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SIEMENS

CARRIER-FREQUENCY SWEEP MEASURING SETUP

10 kc/s to 15 mc/s
with crystal lock-in

Type **Rel 32 M 701**

Full Information

Rel gesamt 32 M 701 En

SIEMENS AKTIENGESELLSCHAFT

October 1966 Rel gesamt 32 M 701

C O N T E N T S

Part 1	Application	Pages 1.1 to 1.14
Part 2	Operating Instructions	Pages 2.1 to 2.40
Part 3	Maintenance Hints	Pages 3.1 to 3.3
Part 4	Testing and Fault Finding	Pages 4.1 to 4.8
Part 5	Diagrams	

Additional information may be requested from any local branch office
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Wernerwerk für Weitverkehrs- und Kabeltechnik
Abt. Nachrichten-Meßgeräte, 8 München 25, Hofmannstraße 51

SIEMENS AKTIENGESELLSCHAFT

A P P L I C A T I O N

For the development, testing and maintenance of multichannel communications systems, there is a need for measuring equipment which will give a rapid and reliable check of the transmission quality. The modern trend is to replace point by point measurements by the sweep technique.

The components, equipment and groups of equipment vary considerably in their function, bandwidth and frequency position. In some cases it is necessary to measure very small differences in attenuation over a wide frequency range and in others large differences in attenuation over small frequency bands.

The advantages of sweep measurement are already well proven. Sweep techniques provide a distinct continuous curve of the characteristics of the specimen to be measured on the screen of a cathode ray tube, with considerable saving of time.

fulfills these varying requirements of sweep range and sensitivity with very high accuracy and has a frequency range which covers all wideband carrier systems up to 2700 voice channels which are at present in operation, e.g. the systems V 300, V 960, V 1200, V 2700, and the basebands of multichannel radio link systems FM 600, FM 900 and FM 1800. Using the balancing transformers B 216 and B 218 it is also possible to carry out measurements on balanced systems. This setup can be used in the frequency range 10 kc/s to 15 mc/s for practically all measurements which can, either directly or by means of accessories, be converted into voltage measurements.

The Sweep Oscillator

consists of the level oscillator W 518 which by means of the sweep attachment W 933 is extended into an electronically controlled sweep oscillator. The level oscillator is in principle a beat frequency oscillator and can be tuned by means of the f1 oscillator over the range 0 - 17 mc/s in one band. Its f2 oscillator has an additional fine tuning range of 0 - 100 kc/s. When used as a swept generator one of these two oscillators is replaced by a sweep oscillator. Large sweep widths can be obtained by means of the sweep oscillator W 937 which replaces the f1 generator in the level oscillator and for narrow sweep widths the sweep oscillator W 938 replaces the f2 generator. The two sweep oscillators are in the form of plug-in units which can be selected as required and plugged into the sweep attachment W 933, which contains all electronic control circuits. The setting of the center frequency of both sweep oscillators is independent of the sweep width. By means of crystal control and lock-in circuits, a very simple, but nevertheless, very accurate evaluation of the frequency is guaranteed. (For more details of the layout and function of the transmitting section refer to the description "Sweep Attachment W 933").

is the level tracer D 346. In electrical and mechanical design, particular importance has been attached to its universal application. By displaying the measured result on a large screen a high resolution has been achieved. The accuracy of the measuring setup can therefore be fully exploited.
Universal application results mainly from the fact that the level tracer consists of a basic unit and various plug-in units. The basic unit contains the indicator circuits with cathode ray tube, final amplifiers for the X and Y deflection and the power supply unit. Easily interchangeable measuring amplifiers and a frequency marker plug-in unit enable the level tracer to be used for a wide variety of different measurements.

A 26 cm tube with a long-persistence screen and magnetic deflection has been chosen for the display. In a vertically arranged line system (20,000 lines over the area of the tube) which is normally biased off, the measured curve and at the same time the frequency and level line coordinate graticule, is produced by means of brightening pulses. This graticule can be chosen to suit the particular measurement being carried out.
The crossover points between the measured curve, the frequency lines and the level lines enable accurate evaluation since the measured curve is not interrupted or displaced. It can be observed from any angle and measuring errors due to parallax or distortion of the display are not possible.

With this comparatively new measuring technique a reading accuracy which is at least equal to that of moving-coil instruments is obtained. The long persistence of the cathode ray tube enables the measured results to be seen as a continuous curve even with the lowest sweep speeds.

The level oscillator, sweep attachment with oscillator plug-in unit and level tracer with wideband amplifier alone make up a complete sweep measuring setup.
By means of the measuring probe B 939, a DC voltage proportional to the sending voltage is fed from immediately in front of the input of the specimen to a regulating amplifier built into the sweep attachment. By this means a very constant transmitting level is maintained over the whole frequency range and matching errors in the external circuit are essentially overcome. With this basic setup, attenuation differences of less than $\frac{1}{100}$th of a db and levels down to -60 db can be seen.

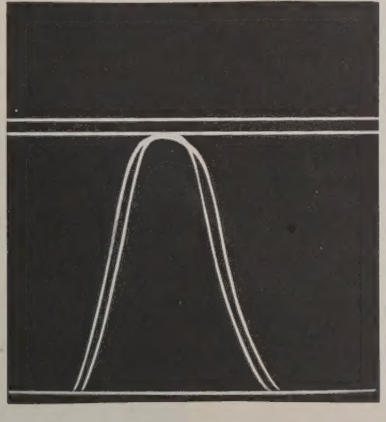
This wideband sweep measuring setup can be further extended into a selective sweep setup by connecting the level meter D 335 in front of the level tracer, and replacing the wideband amplifier by the IF amplifier plug-in unit. The level meter then functions as a selective pre-amplifier, its frequency tuning being automatically synchronized from the level oscillator. By this means selective measurements which must be carried out for purposes of frequency separation are made as easily as wideband measurements. In addition all the advantages of selective measurement, including the high sensitivity of a level meter, can also be exploited when using the sweep technique.

Frequency analysis is just as feasible as the usual selective measurement since the sweep attachment can also directly control the frequency tuning of the level meter. An arrangement consisting of the sweep attachment, selective level meter and level tracer forms a complete measuring setup for such work.
The monitoring of carrier systems provides many applications since the interference of individual channels and the attenuation distortion within the whole transmission band can be displayed directly on the screen of the cathode ray tube (panoramic reception). This way an overall picture of the condition of the system can be obtained in a very short time.

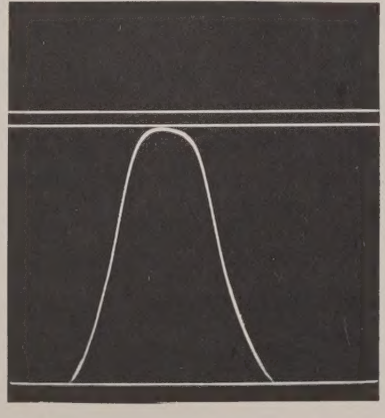
The Sweep Speed

The determination of the maximum permissible sweep speed is, by virtue of the technique used, extremely simple. The frequency of the sweep oscillator is controlled by a varactor diode and is, therefore, instantaneous in operation. It has therefore been possible to choose a symmetrical, triangular wave as the deflection voltage for the sweep oscillator and the X-deflection. This has one great advantage over other wave forms (e.g. saw-tooth voltage); the trace can be displayed on both forward and return sweeps (no flyback suppression). This means that transients which can result from an adverse relationship between the time constant of the specimen and the sweep frequency, can be recognized without, in many cases, complicated calculation, since the curves of both forward and return sweeps will then no longer be coincident. Measuring errors due to transients are avoided provided that the curves of the forward and return trace are made coincident.

The sweep frequency, which can be varied between 0.01 and 25 c/s, can always be set to an optimum value dependent on the transient response of the specimen, even when measuring narrow band specimens with steep characteristics. Here the long persistence of the cathode ray tube is particularly useful. Even when using the longest sweep time (100 sec for the trace to cross the tube face) both the forward and return traces can be seen.



Sweep speed
too high



Sweep speed
correct

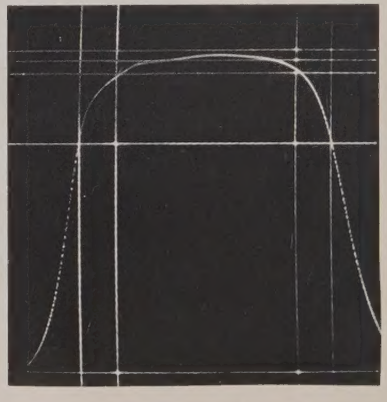
If it is required to carry out point-by-point measurements on very steep-sided filters, or small resonant peaks of crystal filters with a pass-band of only a few cycles, it is possible to switch off the automatic frequency sweep and tune manually, the electronic graticule still being traced simultaneously.

The Sweep Width

The sweep width can be set anywhere between wide limits from a few hundred cycles to ± 7.5 mc/s. It is possible to sweep over the whole band (10 kc/s to 15 mc/s) and also any partial band within this frequency range. The center frequency stays practically constant even though the sweep width is varied. By means of an equalizing network in the sweep attachment, the frequency sweep remains approximately linear even with maximum sweep widths. The full width of the screen is always utilized no matter what the sweep width.

The Coordinate Graticule

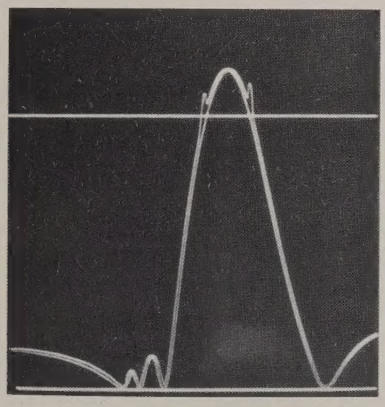
A coordinate graticule consisting of frequency lines and level lines is traced out simultaneously with the measured curve. These lines can be adjusted independent of each other in both position and brightness and can be accurately calibrated without auxiliary instruments. It is thereby possible to produce a calibrated measuring scale or a tolerance scale, suited to a particular measurement. Within this tolerance scale the measured values of frequency and level can be very accurately read without parallax error.



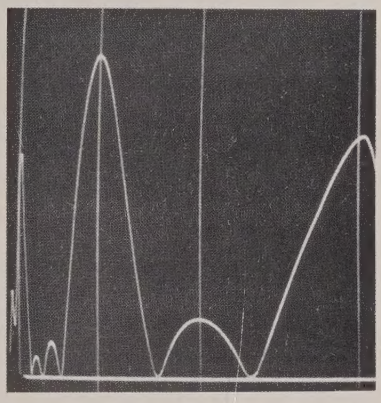
Measured curve and coordinate graticule

Frequency Markers

Frequency markers are shown as vertical lines on the screen. They are independent of the measured curve which is therefore not affected by them even on steep sided and narrow band specimens. They can also be produced as pips modulated on the transmitting signal.



Frequency markers modulated on the transmitting signal (double exposure)



Frequency marker lines for the measurement of filter poles

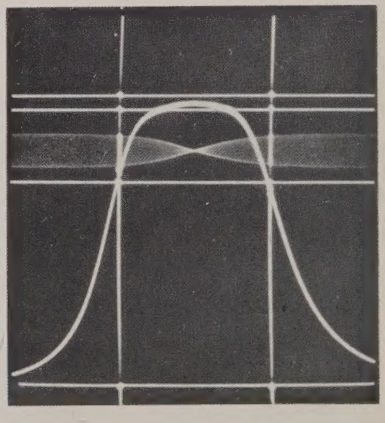
When using wide sweep the crystal controlled f1 oscillator of the level oscillator is available as a frequency marker oscillator. An additional crystal oscillator is therefore unnecessary.

Apart from this one frequency marker line which is taken directly from the f1 oscillator, two further vertical lines are available which can be moved over the whole width of the tube and calibrated with the first line. By this means three crystal accurate frequency lines are available without external instruments. Frequency meters which would otherwise be necessary, for instance when adjusting filters, are therefore dispensed with.

When making selective measurements the crystal controlled f1 oscillator of the level meter can also be used as a second additional marker generator. Four frequency markers of high accuracy are therefore available without additional equipment. All frequency markers can be set to any desired frequency within the whole frequency range independent of each other.

Further frequency markers can be added to the main marker in the form of secondary markers above and below the main marker by modulating the f1 oscillator with the output voltage of an auxiliary oscillator. These secondary markers are spaced above and below the frequency of the main markers from the level oscillator and level meter by a frequency equal to that of the auxiliary oscillator. The frequency error of the auxiliary oscillator affects the accuracy of the secondary markers only in the ratio of the difference in frequency between the auxiliary and main oscillator frequency to the main oscillator frequency so that for this purpose any commercially available oscillator can be used. It is therefore possible to produce eight frequency markers, including the secondary markers, simultaneously with the measured curve.

When using narrow sweeps with the sweep oscillator II the fine tuning oscillator f2 of the level oscillator is used for the marker signal. In this case also the frequency marker is independent of the measured curve. It is displayed as a modulation envelope and, as with wide sweeps, can be used to calibrate two vertical lines.



Frequency marker shown as modulation envelope with two frequency marker lines

Level Lines

For measurement of the signal level it is possible to display up to eight horizontal lines. These are also independent of the measured curve and can each be moved over the full vertical height of the screen and very accurately calibrated.

High Measuring Accuracy requires, apart from a constant transmitting level with a flat frequency response, a low matching error in the external circuit and a high calibration and reading accuracy. On the transmitting side these requirements are fulfilled by automatically maintaining the transmitting level constant at the input of the specimen by means of a probe.

A calibrate line is traced by taking a highly stable DC voltage from the receiver. It can be set in 10 steps of 1 db and 10 steps of 0.1 db, by means of a very accurate potential divider. In addition, up to eight graticule lines can also be traced, each of which can be moved over the whole height of the screen and calibrated by means of the calibrate line. It is thereby possible to build up an accurate level scale.

When making wideband measurements the sensitivity for full deflection can be set in 5 db steps down to -40 db full deflection by means of a very accurate attenuator in the wideband amplifier. A measuring range of uniform accuracy down to -50 db is thus obtained, and within this range it is possible to display the tolerance scale divided into 0.1 db steps. A calibrating voltage from the level tracer enables the calibrate line to be standardized absolutely.

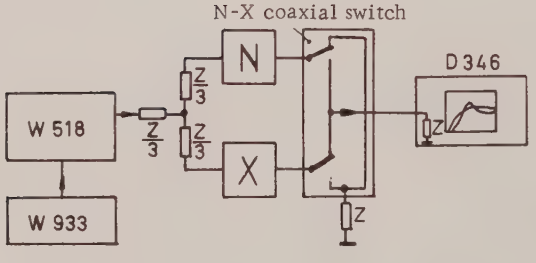
Careful construction and the choice of close-tolerance, high-quality resistors have enabled a small internal reflection coefficient and a high measuring accuracy to be achieved for the attenuator and the calibrate line divider.

The absolute errors and the frequency dependent errors are of the order of a few tenths of a percent over the whole measuring range. Additional attenuators with high accuracy are therefore unnecessary.

Maximum indicating sensitivity on the screen is obtained by expanding the vertical deflection. With full expansion a level change of 0.1 db produces a deflection of approximately 15 mm. By this means level differences of the order of tenths of a percent can be seen.

The Comparison Method (N-X Method)

is one of the methods by which this increased reading accuracy can be exploited. The four terminal network which is to be measured, is compared with a standard network which has already been adjusted, or with an attenuator, and the deviations of the specimen X from the standard N are measured. The errors of the measuring equipment and the circuit arrangement do not therefore affect the final measured result.



N-X comparison with expanded level scale

The N-X-Switch changes over from the standard N to the specimen X in synchronism with the sweep, so that the curve of N is traced on the forward sweep and the curve of X on the return sweep. The additional errors due to the reflection coefficient of the coaxial switch are negligible. Trimming adjustments are very easily carried out in this manner since it is only necessary to make the two curves coincident. In addition a high equality of specimens is obtained.

The comparison method simplifies production series measurements even though the requirements of measuring accuracy may not be so high. The expanded level scale simplifies the reading of the measured values. It is therefore particularly useful for the testing of large quantities of similar specimens.

Measurement of Large Differences in Attenuation

The following method shows how it is possible to accurately measure the pass-band and stop-band in one operation.

First of all the pass-band is displayed in the upper third of the screen and with the level range switch of the level meter (or the wideband amplifier) is set so that the curve of the stop-band appears approximately in the middle of the screen.

With the measuring setup calibrated in this manner the testing and adjustment of further specimens is easy. It is only necessary to switch the level switch between the two predetermined positions. In one case the pass-band is displayed and in the other the stop-band.

By connecting the N-X Switch into circuit the measurement is considerably simplified.
Switching of the sensitivity is unnecessary; instead the coaxial switch connects an appropriate pad (attenuator) either in front of or behind the specimen, switching it in and out in synchronism with the sweep. With attenuation switched in, the pass-band is displayed in the upper portion of the screen and with the attenuation switched out, the stop-band is shown in the lower portion. From the eight available level lines, the required tolerance scale for both ranges can be set. In both cases the resulting measured values have the full measuring accuracy. Any excursions outside the tolerance in both the pass-band and the stop-band are immediately visible on the simultaneously produced graticule. The size of the screen always permits a distinct separation of the two ranges, (for further information and layout of the measuring setup see Operating Instructions diagram 7).

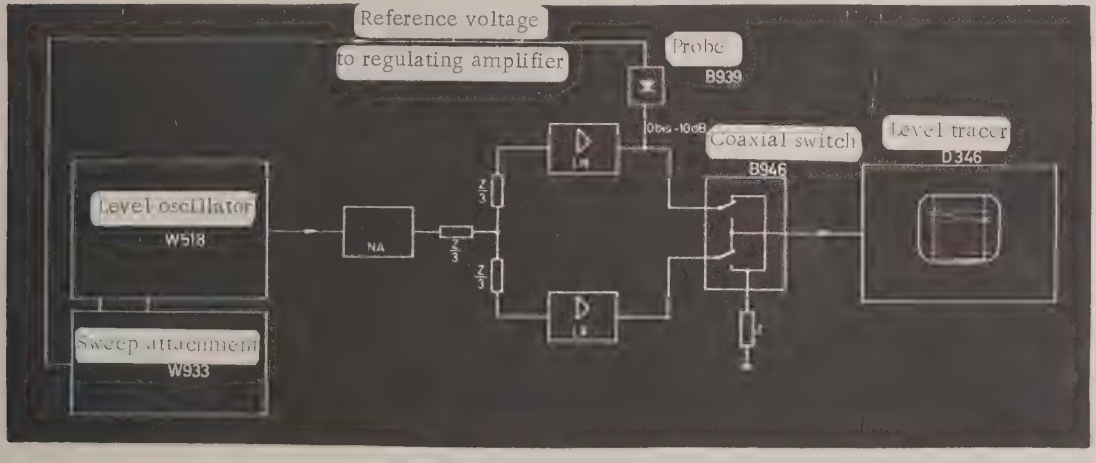
Measurements with Measuring Probe B 939

By means of the measuring probe B 939, the transmitting level immediately at the input of the specimen can be held constant by a regulating circuit in the sweep attachment, i.e. the frequency response of the external circuit is also flattened. For all measurements with wide sweep where high accuracy is required, it is recommended that the measuring probe is always used.

In addition there are further applications where this technique can be used with advantage and the following example explains one of these in more detail:

In carrier systems the frequency dependent attenuation of the cable (approx. 60 db) is compensated for by means of equalizing line amplifiers. The testing and adjustment of these amplifiers requires much care and time, particularly when close tolerances have to be maintained over a wide frequency range and large quantities have to be tested. (Measurement with a logarithmic level scale is not good enough since the measuring accuracy over a large attenuation range is insufficient).

By using the following technique these adjustments can be considerably simplified and the time reduced. First of all an amplifier, individually adjusted very accurately to the attenuation characteristic required, is used for the comparison standard (LN) for the amplifier to be adjusted (LX) and a building-out network whose attenuation characteristic corresponds exactly to the amplification characteristic of the line amplifier (image response) is made common to both circuits. The building-out network and the two equalizing amplifiers are decoupled by means of a T-network. The coaxial NX switch is used to change over from the standard amplifier (LN) to the specimen amplifier (LX). The output from the standard LN is used as a reference voltage and fed to the regulating amplifier in the sweep attachment via the measuring probe.



Measuring Procedure

First of all manually switch the coaxial switch to the branch containing the building-out network and amplifier LN and after removing the probe, adjust the attenuation characteristic of the building-out network NA, using the sweep, so that the curve appears approximately as a straight line. (Permissible distortion approx. ± 3 db). Connect the measuring probe thereby making the regulating circuit which will flatten out the response due to the building-out network. The curve on the screen must now be traced as a straight line.

Now set the coaxial switch to automatic operation. The curve of the standard LN and specimen LX are now both traced on the screen. Since the standard curve is displayed as a straight line, the level tracer will indicate directly the level difference between the standard and the specimen. To adjust the specimen the two curves must be made coincident. By means of the level expansion, differences in level of the order of tenths of a percent can easily be seen and can be measured with the aid of the simultaneously traced level lines. This automatically ensures a high degree of uniformity between all the equalizing amplifiers.

Recording of the Measurements

The following methods can be used:

1. An X-Y-recorder can be connected to the sockets provided on the level tracer.

2. The display can be photographed with an oscilloscope camera.

   We recommend the oscilloscope camera type B 952 which has a Polaroid back and produces a picture within 10 seconds. Interchangeable adapters are available to enable the camera to be used with various different oscilloscopes. The camera is easy to operate and the use of a wide angle lens keeps its overall dimensions small.

The above examples provide only a general picture of the use of this measuring setup, whereas in practice many other applications can be found.

O P E R A T I N G I N S T R U C T I O N S

CONTENTS

I. Introduction 2.3

II. Layout of the Measuring Set-up 2.5

A. Broadband Measurements (minimum receive level approx. -60 dB)

1) Sweep width ± 8 Kc/s to ± 7.5 Mc/s 2.8

2) Sweep width ± 500 c/s to approx. ± 10 Kc/s . . . 2.8

B. Selective Measurements (minimum receive level approx. -100 dB) 2.9

1) Sweep width ± 8 Kc/s to ± 7.5 Mc/s 2.9

2) Sweep width ± 500 c/s to approx. ± 10 Kc/s . . . 2.9

3) Frequency Analysis 2.10

C. Measurements with Ancilliary Equipment 2.12

1) Reflection coefficient 2.12

2) Comparison Measurements with the N-X Coaxial Switch 2.12

a) For large numbers of similar specimens . . . 2.12

b) For the measurement of very small level difference 2.12

c) On specimens with large differences of of attenuation 2.12

III. Setting-up Procedure 2.13

1) Brightness 2.13
2) X-Y Position 2.13
3) Centre Frequency 2.13
4) Sweep Width 2.15
5) Sweep Frequency 2.16
6) Frequency Markers 2.17
7) Horizontal Expansion 2.25
8) Tolerance Scale 2.25
9) Vertical Level Expansion 2.28
10) Tolerance Scale with Vertical Level Expansion . . . 2.28

IV. Calibration 2.29

1) ▼ I (-00 line) 2.29
2) Calibration for Broadband Measurement 2.30
3) Calibration for Selective Measurement 2.31

V. Functional Check 2.32

VI. Measurement 2.35

1) With Regulated Sending Level 2.35
2) Of Relative Level Differences 2.37
3) Of Absolute Levels 2.38

I. INTRODUCTION

Compared with point by point measurements the use of sweep techniques involves a number of additional operating procedures, e.g. setting the sweep width and the sweep frequency, setting the coordinate graticule, taking into consideration the transient response of the network to be measured etc. A certain amount of practice is therefore unavoidable, particularly if the full capabilities of this sweep measuring set-up are to be exploited.

The most important condition for rational exployment of this equipment is a thorough knowledge of the electrical functions and different characteristics of the individual instruments and plug-in units. We recommend therefore that users should familiarise themselves with the operation of the individual instruments.

Before putting the equipment into operation it is useful to carry out a functional check (operating instructions page 30) in order to become familiar with the individual functions and controls. The instruments are set in the factory for connection to 220V a.c. mains and before connecting to other mains supplied the appropriate voltage should be set on the mains voltage selector, which is accessible when they are removed from their cases.

In the level oscillator W 518 and level meter D 335:

Switch S6 on the upper side of the power unit sub-assembly near the mains transformer

In the sweep attachment W 933:

Switch S2 at the rear of the instrument above the mains transformer TR1 in the power unit.

In the level tracer D 346:

Switch S4 on the right-hand side in the power unit (accessible after removing the frequency marker plug-in unit. The main equipment need not be removed from its case).

For mains voltages of 110 or 130 volts, 2 A fuses should be inserted in the level oscillator W 518 and the level meter D 335, and 4 A fuses in the sweep attachment W 933 and the level tracer D 346.

In accordance with the safety requirements of the Association of German Electrical Engineers (VDE) all mains operated instruments, where the chassis can reach a potential of 65V with respect to earth in the event of a short circuit, must be provided with an earth terminal.

All these instruments are therefore provided with an earth wire in the power lead and special safety plug (Schuko plug). The gauge of this earth lead must be equivalent to that of the current carrying leads.

If the mains plug provided is to be changed with one appropriate to local requirements, then the three wires should be connected as follows:

For two pin plugs:

Red lead should be connected to earth
Grey and black leads to the current carrying pins

On universal plugs used on supplies with neutral conductors:

Red lead should be connected to earth
Grey lead to neutral
Black lead to live

N.B. If the main supplies are not provided with an earth lead then a suitable, interference-free, independent, earth connection should be made to the terminal marked ("$\perp$") on the front panel. In this case when changing the plug provided the red lead should not be connected, but completely insulated and the grey and black leads connected to the current carrying conductors. Under no circumstances should the earth lead be interrupted during the setting up or the operation of the equipment.

II. LAYOUT OF THE MEASURING SET-UP

The instruments should be placed with their front panels vertical and the ventilation holes on the top of the instrument cases should not be obstructed. It is permissible to stand the level oscillator on top of the sweep attachment, but under no circumstances must another instrument be placed on top of the level tracer.

Approximately 15 minutes after switching on and before inserting connecting cords, the frequency and level calibration and also the synchronisation of the level oscillator and level meter should be checked. (See brief operating instructions for the Carrier Frequency Measuring Set-up 17 Mc/s part VII). The complete measuring set-up should then be assembled and a functional check carried out as described in part V, page 30.

The measuring set-up can be arranged for:

A. Broadband Measurements (minimum receive level approximately -60 dB)

B. Selective Measurements (minimum receive level approximately -100 dB)

Other variations in the set-up will depend on the sweep width being used. The table on page 6 indicates the instruments and plug-in units required for each particular type of reception and sweep width.

The comparison voltage for maintaining a constant send level is obtained by means of the measuring probe B 939, which should always be used for precision measurements with wide sweeps.

To avoid measuring errors the recommended connecting cords should always be used and in particular the sockets "Synchronise f1 and f2" (level oscillator - level meter W 518/D 335) should always be connected by means of the 75Ω double-screened connecting cords type Rel 657A 119 c4, irrespective of the impedance of the specimen.

arrangement of instruments, adaptors, plug-in units and connecting cords.

	SWEEP WIDTH			
	±8Kc/s to ±7.5 Mc/s		± 500c/s to ±10Kc/s	
	broadband	selective	broadband	selective
Level Oscillator W 518	x	x	x	x
Level Meter D 335		x		x
Sweep Attachment W 933	x	x	x	x
Sweep Oscillator I, W 937	x	x		
Sweep Oscillator II,W 938			x	x
Level Tracer D 346	x	x	x	x
Broadband Amplifier D917	x		x	
I.F. Amplifier D 916		x		x
Frequency Maker Plug-in unit D 928	x	x	x	x
Measuring Probe B 939	x	x		
Auxiliary Oscillator for frequency markers (e.g.W518)	x	x		

For connecting to specimens with other types of plug and socket the following adaptors and couplings are recommended.

Rel stv 112a	Plug 2,5/6	- Socket 4/13 mm
Rel stv 113a	Plug 4/13	- Socket 2,5/6 mm
C 42334-A83-A6	Plug 1,6/5,6	- Socket 2,5/6 mm
C 42334-A83-A8	Socket 1,6/5,6	- Socket 2,5/6 mm
9 Rel stv 3a	Socket 4/13	- Socket 4/13 mm
Rel stv 157b	Plug 2,5/6	- 2xSocket 2,5/6 mm

75Ω Terminations

Rel 3 B 333a	Plug 4/13 mm
Rel stv 126b	Plug 2,5/6 mm
V 42252-C3-A1	Plug 1,6/5,6 mm

			SWEEP WIDTH			
Type No.	Class of plug	Length in mm	± 8Kc/s to ±7.5Mc/s broadband	selective	±500c/s to ± 10Kc/s broadband	selective
Rel 1tg 546d	balanced	2000	1x	1x	1x	1x
Rel 1tg 664i	balanced	4000	1x	1x	1x	1x
Rel 1tg 546a	balanced	500	1x	2x		1x
Rel 1tg 533d	4/13 mm	1000	1x	1x	1x	1x
Rel 1tg 533b	4/13 mm	500		1x		1x
Rel 1tg 598d	4/13-2, 5/6 mm	1000	2x	1x	1x	
Rel 1tg 598b	4/13-2, 5/6 mm	500	1x	1x		
*Rel 1tg 592b	2,5/6 mm	500	2x	2x	2x	2x
**Rel Bv 657 A 119 c4	4/13 mm	1000		2x		2x

* Already supplied as accessories with sweep attachment Rel 3W 933

** Already supplied as accessories to level oscillator Rel 3W 518 from series Rel 3W 518f .. onwards.

Optional Connecting Cords

Rel 1tg 592d	2,5/6 mm	Length 1000 mm
Rel 1tg 592b	2,5/6 mm	length 500 mm
Rel 1tg 538d	bal.-4/13 mm	length 1000 mm

A. Broadband Measurements

Minimum readable level approximately -60 dB

1. Sweep Width ± 8 Kc/s to ± 7.5 Mc/s

a) Without automatic level regulation
For investigations with wide sweep widths from approximately ± 100 Kc/s to ± 7.5 Mc/s
For precise measurements with narrow sweep widths from ± 8 Kc/s to approximately ± 100 Kc/s
The measuring set-up as shown in attached diagram 1a.

b) With automatic level regulation
For accurate measurements even with wide sweep widths of up to ± 7.5 Mc/s
The sending level is regulated by means of a built-in regulating amplifier and the measuring probe B 939.

Application: e.g. when measuring the frequency response of line amplifiers, band-pass filters, cables and components. With five frequency markers (Satelite frequency markers provided by means of an auxiliary oscillator)

Measuring set-up as shown in attached diagram 1b.

2. Sweep width ± 500 c/s to approximately ± 10 Kc/s

Level regulation by means of the regulating amplifier and measuring probe is not necessary since the oscillator output voltage remains practically constant for small sweep widths.

Measuring set-up as shown in attached diagram 2a.

B. Selective Measurements

For the measurement of large attenuation differences; minimum readable level approximately -100 dB.

The level meter D 335 is used as a selective pre-amplifier in front of the level tracer and the I.F. amplifier replaces the broadband amplifier in the level tracer.

1. Sweep Width ± 8 Kc/s to ± 7,5 Mc/s

a) Without automatic level regulation
For investigations with wide sweeps from approximately ± 100 Kc/s to ± 7.5 Mc/s
For accurate measurements with narrow sweep widths from ± 8 Kc/s to approximately ± 100 Kc/s.

Application: The measurement of stop-band characteristics of filters.

Measuring set-up as shown in attached diagram 2b.

b) With automatic level regulation for accurate measurements even with wide sweep widths from approximately ± 100 Kc/s to ± 7.5 Mc/s.

Application: For measurements where a high degree of accuracy is required, e.g. attenuation networks, frequency dividing networks, filters and amplifiers.

Measuring set-up as shown in attached diagram 3a.

2. Sweep widths ± 500 c/s to ± 10 Kc/s

Level regulation by means of the regulating amplifier and measuring probe is unnecessary since the sender output voltage remains practically constant with small sweep widths.

Application: For the measurement of very small partial bands, e.g. on filters and for accurate analysis of filter attenuation poles.

Measuring set-up as shown in attached diagram 3b.

3. **Measurement of traffic in a carrier frequency system which during operation**

For this purpose the frequency of the level meter is swept as follows:

a) With level meters of the series D 335d..., e...:
By means of the level oscillator via the synchronisation of the level oscillator to the level meter. Calibration of the measuring set-up and setting of the frequency markers is the same as for selective measurement.

Measuring set-up as shown in attached diagram 4a.

b) With level meters of the series D 335 f...:
The receive frequency of the level meter can be directly swept (a level oscillator is unnecessary).

Setting the Frequency Markers: By means of frequency tuning f1 on the level meter.

Measuring set-up as shown in attached diagram 4b.

Application: For the display and measurement of traffic in a carrier frequency system which during operation. If no 75 Ω input connection is available it is recommended that the high impedance probe B 938 should be used. If narrow band-sweep is required (± 500 c/s to ± 10 Kc/s) the sweep oscillator II should be plugged into the sweep attachment and the sweep sockets "C-D" between sweep oscillator and level meter should be connected.

Setting the Centre Frequency

Course setting is carried ou on the "Mc/s" scale of the level meter and fine setting is carried out on the "Kc/s" scale of the sweep oscillator.

Setting the Frequency Markers

This is carried out by means of the frequency tuning f2 of the level meter.

C. Measurement with Ancilliary Instruments (Broadband or Selective)

1. Measurement of Reflection Coefficient with the Reflection Coefficient Measuring Bridge R 132

Application: For the measurement of the frequency response of reflection coefficient of, a line or a filter or amplifier input, etc.

Measuring set-up as shown in attached diagram 5.

2. Measurement with the N-X coaxial switch B 946

Application:

a) Testing large numbers of similar specimens using the comparison method (the specimen X is compared with a standard N).

b) Measurement and adjustment to the highest order of accuracy using the comparison method. The minimum readable level difference with maximum level expansion is approximately 0.01 dB. Measuring set-up as shown in attached diagram 6.

c) Measurement and adjustment of specimens with large attenuation differences, e.g. measurement of the pass-band and stop-band of filters and frequency dividing networks with the equal accuracy and also of attenuation differences of up to 80 dB. Minimum readable level approximately -100 dB.
Measuring set-up as shown in attached diagram 7.

III. S E T T I N G U P O P E R A T I O N S

1. Brightness (Fig. 1)

The brightness settings are carried out on the level tracer as follows:

Brightness of the measured curve by means of P14
Brightness of the level calibrating line by means of P16
Brightness of the level line grid by means of P15

2. X-Y Positive (Fig. 1)

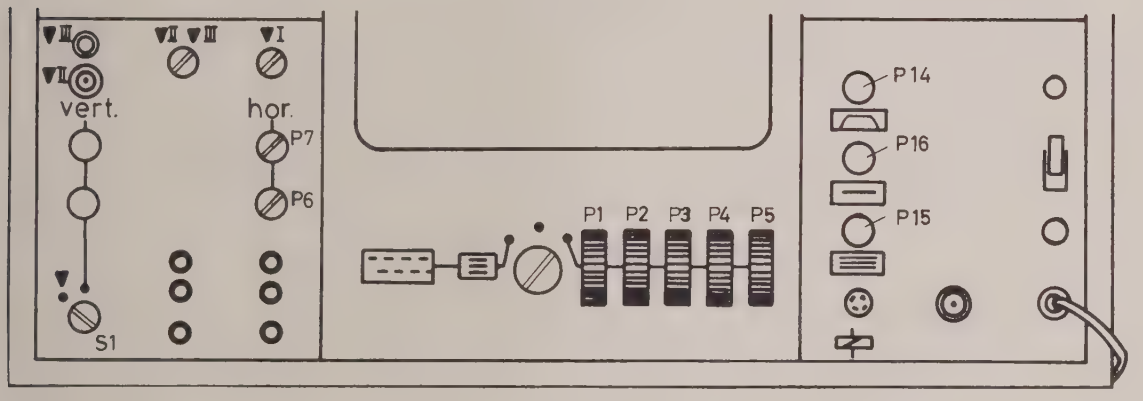


Fig. 1
Level tracer
lover part

Operate the equipment without vertical or horizontal expansion. Set the vertical deflection switch S1 to "▼". Adjust P6 and P7 (horizontal deflection) so that the full width of the screen is used to display the measured curve. This is only possible when a horizontal deflection voltage is applied to the level tracer and the sweep frequency of the sweep attachment is not set to "0Hz".

3. Centre Frequency

a) Sweeping with wide sweep widths (± 8 Kc/s to ± 7.5 Mc/s)

With sweep oscillator I, W 937 (Fig. 2a) the f2 setting of the level oscillator is added to the centre frequency setting of the sweep oscillator. For sweep widths greater than ± 200 Kc/s it is better to set the f2 scale of the level oscillator to 0 Kc/s.

For sweep widths from ± 10 Kc/s to approximately 200 Kc/s the centre frequency on the sweep oscillator should be set to a multiple of 100 Kc/s and intermediate values should be set on the f2 scale of the level oscillator. This facilitates the setting of frequency markers.

Example:

It is required to measure the pass band of a band-pass filter whose centre frequency is 625 Kc/s and whose pass-band is 50 Kc/s.
Setting:
Centre frequency on the sweep oscillator I 600 Kc/s
Frequency f2 of the level oscillator 25 Kc/s

b) Sweeping with narrow sweep widths (± 500 c/s to ± 10 Kc/s)

With sweep oscillator I, W 938 (Fig. 2b)

The centre frequency is the sum of the frequency f1 of the level oscillator and the setting of the centre frequency of the sweep oscillator II.

Example:

Required centre frequency 3422 Kc/s.
Setting of the level oscillator f1 scale: 3.4 Mc/s (with lock-in)
Setting of the sweep oscillator II: 22 Kc/s.

Fig. 2a
Sweep Oscillator I

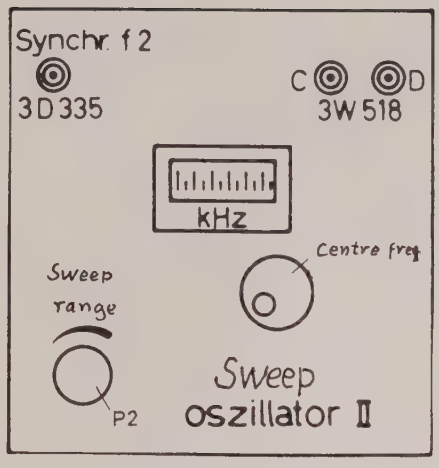


Fig. 2b
Sweep Oscillator II

4. Sweep Width

a) Sweep Oscillator I, Fig. 2a

The four position switch S6 is used for course setting and potentiometer P6 for fine adjustment between any two settings of S6.

Example:

It is required to measure the pass-band attenuation of a 10 Mc/s band-pass filter, the centre frequency and pass-band of which is 10 Mc/s and ± 200 Kc/s respectively.

Setting:

The centre frequency of the sweep oscillator I is set to 10 Mc/s.

The sweep width is set coarsely with S6 to 80 ... 800 Kc/s

fine setting to ± 200 Kc/s is made with potentiometer P6 and can be measured if required by means of frequency markers. See section 6a "Frequency Markers".

b) With Sweep Oscillator II, Fig. 2b

Continuously variable from approximately ± 500 c/s to ± 10 Kc/s by means of the potentiometer "Sweep Width" P8. First set the coarse width (± 10 Kc/s). (The control "Sweep Width" should be set to its right-hand stop). The sweep width should then be slowly reduced. The centre frequency is then re-adjusted so that the required frequency range even with reduced sweep width is still visible on the screen. For this purpose frequency markers can again be used (see section 6e, page 22).

5. Sweep Frequency

This is set by means of the double knob "Sweep Frequency" on the sweep attachment (coarse settings by means of S3 and fine settings by means of the potentiometer P2 between any two settings of S3). First switch to a high sweep frequency and then gradually reduce until the curves of forward and return trace are coincident.

Caution! If the two curves are not coincident then the sweep frequency is too high and the measured result will be wrong due to the transient response of the specimen.

In the position "o Hz" of the switch "Sweep Frequency" the automatic frequency sweep is switched off, enabling the frequency sweep to be manually controlled by means of the potentiometer P1 "Manual Control".

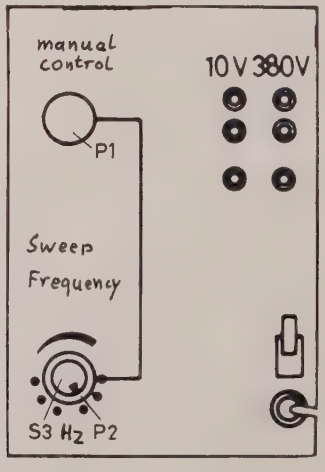


Fig. 3
Sweep Attachement
right-hand part

6. Frequency Markers

With sweep widths of approximately ± 50 Kc/s to ± 7.5 Mc/s

a) Main marker

This is produced as a vertical line, the frequency being set on f1 and f2 scales of the level oscillator.

Example:

Frequency f1 = 7.2 Mc/s, f2 = 43 Kc/s
The frequency marker will be equal to 7.243 Mc/s
If further frequency markers differing by multiples of 100 Kc/s are required refer to section C, page 19.

Adjustment of brightness and width of frequency markers. The brightness and width of the frequency markers must be adjusted to suit the particular sweep frequency chosen. The adjustments are carried out on the frequency marker plug-in unit of the level tracer and on the frequency marker section of the sweep attachment.

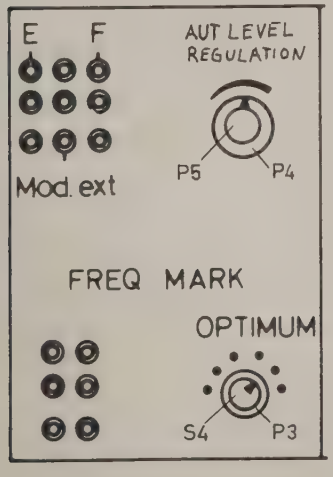


Fig. 4a
Sweep attachment
Frequency Marker section
and Regulating Amplifier

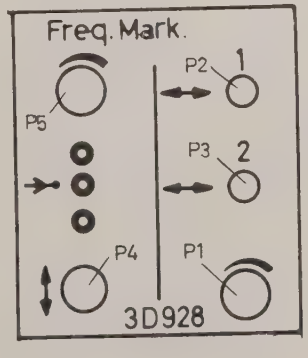


Fig. 4b
Frequency Marker plug-in
Unit in Level Tracer

After these initial adjustments the width of the frequency marker can now be set by means of the fine control "FREQ. MARK OPTIMUM", the brightness of the frequency marker being adjusted where necessary on the frequency marker plug-in unit of the level tracer (figure 4b).

b) Auxiliary Markers

These are displayed as vertical lines.
The frequency marker plug-in unit produces pulses independent of the sending frequency by means of which two auxiliary frequency marker lines can be displayed. They can be moved over the whole width of the screen by means of the controls P2 and P3 and with the aid of the main marker can be calibrated to two further desired frequencies by bringing the auxiliary markers into coincidence with the main marker. By this means, three frequency markers are available.

Since the auxiliary markers are produced independent of the sending frequency the centre frequency and sweep width should not be altered after calibration. If this is found to be necessary then the auxiliary markers should be recalibrated. The brightness setting of the auxiliary markers is carried out by means of P1.

c) Satellite Frequency Markers

These are displayed as vertical lines symetrically about the main marker and are produced with the aid of an additional oscillator. This auxiliary oscillator should be connected to the socket "frequency marker external" of the sweep oscillator.

Example 1 (3 frequency markers)
It is required to measure a band-pass filter with a centre frequency of 1.25 Mc/s and a band-width at the 3dB points of ± 25 Kc/s.

Setting the frequency of the main marker:
Frequency f1 of the level oscillator is adjusted to 1.2 Mc/s (with lock-in). f2 is set to 50 Kc/s and the frequency markers for the 3dB band-width = 25 Kc/s are set on the auxiliary oscillator, the required voltage being approximately 0dB.

Since the main marker, and by modulation, the satellite markers, are produced from the sending frequency, the centre frequency and sweep width can be changed after setting up the markers. The position of the frequency markers will move in synchronism automatically if the frequency of the main marker is changed then the satellite markers will also change accordingly. The frequency difference between the main marker and the satellite marker remains the same.

Example 2 (5 frequency markers)
A broadband amplifier with a frequency range 1 to 12 Mc/s has to be measured and frequency markers are required at 1, 6, 8, 10 and 12 Mc/s. The centre frequency 6.5 Mc/s is set up and the sweep width is adjusted by approximately 5.5 Mc/s. Auxiliary markers are set to the extreme frequencies of 1 and 12 Mc/s as described in section b. The main marker (scale f1 of the level oscillator)is set to 8 Mc/s. The auxiliary modulating oscillator frequency is set to 2 Mc/s (8 ± 2 Mc/s = satellite frequency markers of 6 and 10 Mc/s).

d) Obtaining frequency markers from the level meter

This is only possible when measuring selectively and using level meters of manufacturing series D 335 f onwards. Layout of the measuring setup is shown in the attached figure 3a.

The additional frequency markers from the level meter can be set to any desired frequency within the swept frequency range. The frequency is set on the scale f1 of the level meter.

By means of an additional oscillator (connected to the socket "Freq. Mark. ext." of the sweep attachment) satellite markers can be also produced on this frequency marker. These are all produced additional to the satellite and main frequency markers or from the level oscillator. It is therefore possible to obtain two main markers each with two satellite markers. In addition the two auxiliary markers which are set up as described in section 6b can also be produced simultaneously making a total of 8 markers at any one time.

Example:

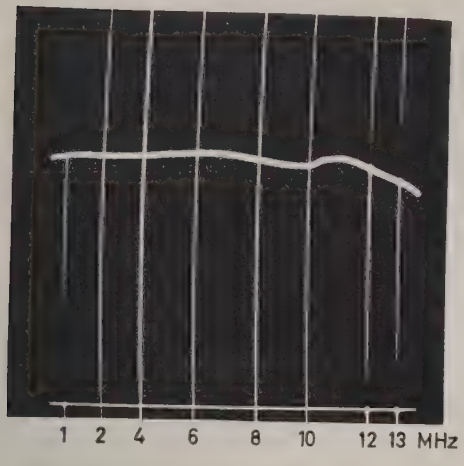
It is required to measure a broadband amplifier with a frequency range of 1 to 12 Mc/s, frequency markers bring required at 1, 2, 4, 6, 8, 10, 12 and 13 Mc/s respectively. First of all set up the auxiliary markers at the extreme frequencies of 1 and 13 Mc/s as described in 6 and 6b, page 19. Then set the level oscillator to read 4 Mc/s and the level meter to read 10 Mc/s. There are now 4 frequency markers at 1, 4, 10 and 13 Mc/s. Plug an auxiliary oscillator whose frequency is set to 2 Mc/s into the socket "Freq. Mark. ext." of the sweep oscillator I and adjust its output voltage to approximately 0dB. This now produces satellite

markers to the main sender (4 Mc/s ± 2 Mc/s, i.e. frequency markers at 2 and 6Mc/s), and satellite markers to the frequency of the level meter (10 Mc/s ± 2 Mc/s, i.e. frequency markers at 8 and 12 Mc/s).

If one of the main frequencies (either on the level oscillator or the level meter) is changed then the associated satellite markers will also change.

Example:

If the sender frequency is changed from 4 Mc/s to 5 Mc/s satellite markers are produced at 5 ± 2 Mc/s, i.e. frequency markers are now produced at 3, 5 and 7 Mc/s.



Frequency response of a broadband amplifier with 8 frequency markers

e) Frequency Markers with sweep widths of ± 500 c/s to approximately ± 50 (100) Kc/s

Fig. 5a
Modulation envelope showing the zero beat as a frequency marker

Fig. 5b
Zero beat of the modulation envelope used as the calibration point of the frequency marker line.

In setting up the curve shown in figure 5a where the zero beat of the modulation envelope is used as a frequency marker the actual frequency of this marker point is equal to the sum of the setting of scales f1 and f2 on the level oscillator.

Example:

Required frequency marker: 148.5 Kc/s

The scale f1 is set to 100 Kc/s with lock-in
The scale f2 is set to 48.5 Kc/s

In addition it is possible to add 2 vertical lines as frequency markers and by means of this modulation curve calibrate these markers. The calibrate point for these lines will be the zero beat point of the modulation envelope curve (figure 5b). The zero beat point of the envelope

curve can be used as a further additional marker. It is therefore possible even with narrow sweep widths to produce 3 frequency markers.

The setting up of these markers is described in section 6b.

Brightness, position and width of the modulation envelope curve

Brightness: This is adjusted on the level tracer by means of control P16

Position: By means of P4 it is possible to adjust the modulation curve vertically to any position on the screen (figure 6a).

Width: By means of the switch S4, "FREQ. MARK. OPTIMUM" on the sweep attachment the width of the modulation envelope can be adjusted to suit a particular sweep width. Fine control is by means of P3 (figure 6b).

Example:

Sweep width 1 Kc/s

Switch S4 to 0.5 - 2 Kc/s

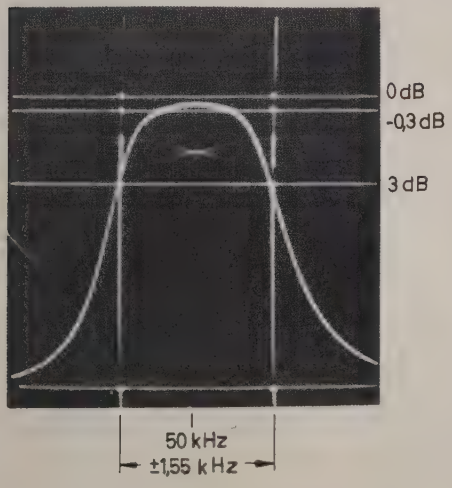


Fig. 6a
Level Tracer, right-hand side

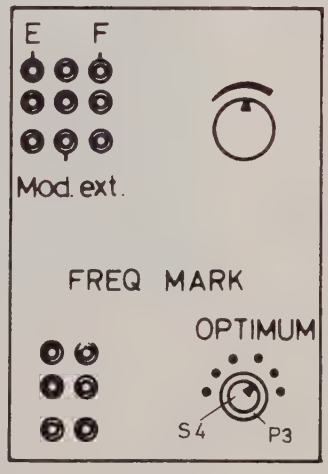


Fig. 6b
Sweep Attachment, right-hand side

f) Frequency Markers modulated on the sending level
(For sweep widths 100 Kc/s)
See figure 7

Set the switch S5 on the sweep attachment to "Sending with Frequency Markers". Connect together the sockets "Mod. ext." of the sweep attachment and the level oscillator (this is not necessary when using level regulation). The frequency of these markers will be the sum of f1 and f2 on the level oscillator. The shape of the markers can be adjusted by means of the switch "Freq. Mark. Optimum" on the sweep attachment.

Fig. 7
Frequency Markers modulated on the sending level shown on the frequency response curve of a broadband amplifier.

7. Horizontal Expansion (figure 8)

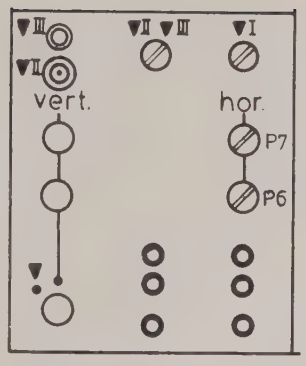


Fig. 8

By means of P7 the X-deflection on the level tracer can be adjusted to suit the deflection voltage from the sweep attachment. By this means it is always possible to make use of the full width of the screen. The control P6 enables the horizontal position of the measured curve to be adjusted without affecting the width of deflection. For the measurement of very narrow band specimens it is also possible by means of P7 to expand in a horizontal direction. Although it is possible to expand by a factor of 10 it is recommended that expansion factors greater than 2 should not be used where precise measurement is required since it is quite possible to introduce measuring errors due to transients occuring which cannot easily be detected.

8. Setting a tolerance grid (figure 9)

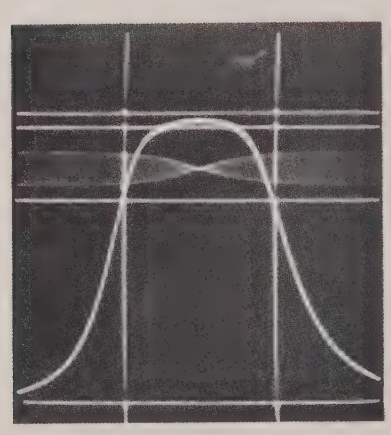
First of all carry out " Calibrate I" (▼I) as described in section IV, page 28. In order to build up a tolerance scale the level calibrate line, which can be adjusted in a vertical direction from + 1.5dB to - 10.5dB in 1dB and 0.1dB steps, is used. The controls are S2 and S3 in either the broadband or IF amplifier plug-in units. The level calibrate line is moved in the desired intervals and grid lines which can be adjusted by means of P1 .... P5 (underneath the c.r.t.) should be brought into coincidence with

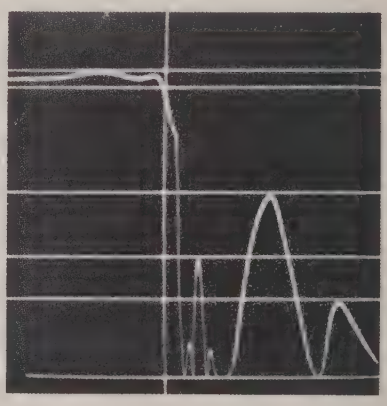
the calibrate line. Switch S2 (which is adjacent to P1 .... P5) should be set fully anti-clockwise.

By means of S1 it is possible to adjust the sensitivity of the broadband amplifier from - 5dB to - 40dB according to what receive level is required.

By means of S1 in the IF amplifier the sensitivity of the level tracer can be adjusted to suit the input signal.

Switch S4 "with/without pre-amp" should be set <u>without</u> pre-amplifier (.0). The pre-amplifier is switched in when the level tracer is operated with other selective level meters which produce a lower output voltage.





Examples of tolerance scales.

Setting up a tolerance scale: Switch S2 fully clockwise. Level calibrate set to the desired attenuation. Adjust the potentiometers P1 and P5 consecutively to produce grid lines by making them coincident with the calibrate line. If the plug-in level line setter B 945 is to be used set S2 to its left-hand stop. 8 level lines can now be produced. With S2 in the centre position all level lines are switched off.

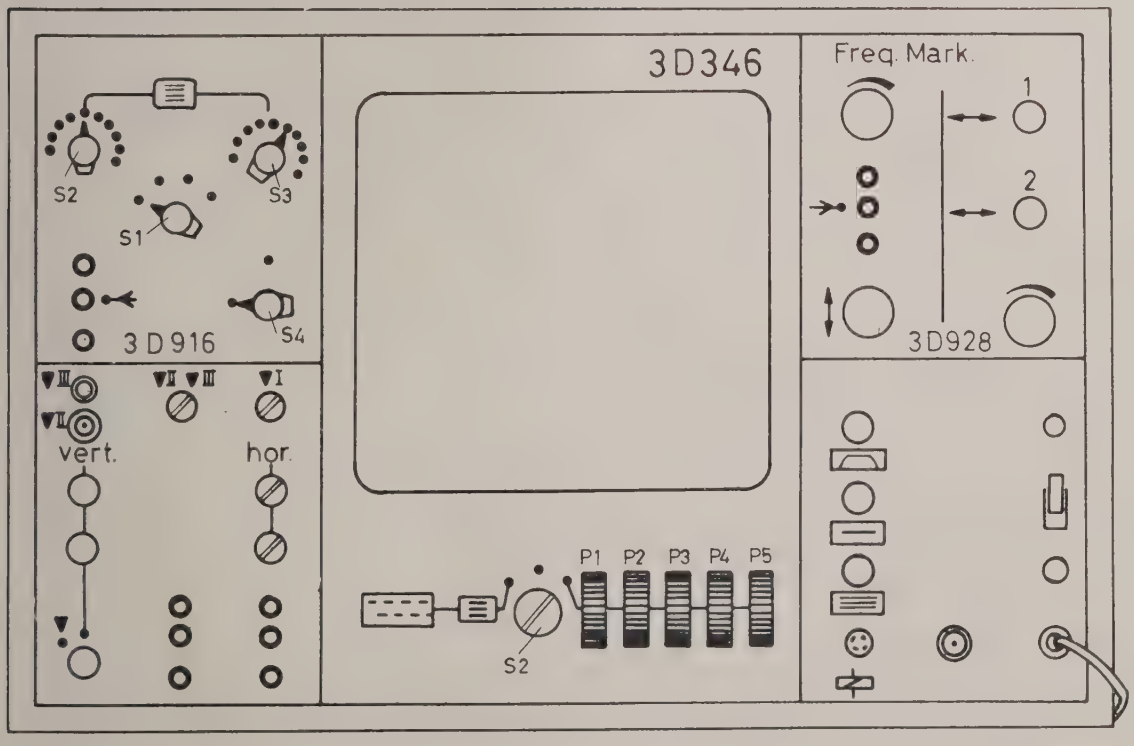


Fig. 9
Level Tracer with IF Amplifier plugged in
Broadband Amplifier shown top left.

9. Vertical Level Expansion

When carrying out measurements with wide sweeps regulated sending level should be used as described in section VI, page 2.35.

Begin by displaying the measured curve without level regulation (S1 to "▼").

Then set S1 fully clockwise (expansion switched in) and P10 fully anti-clockwise and by means of P8 adjust the position of the measured curve into the lower portion of the screen. By means of P10 (turning clockwise) increase the expansion; if the trace disappears from the screen it can be brought back by means of P8 (turned anti-clockwise).

By switching S1 to "▼" the vertical expansion and change of position of the measured curve are switched off and the output condition without expansion is restored.

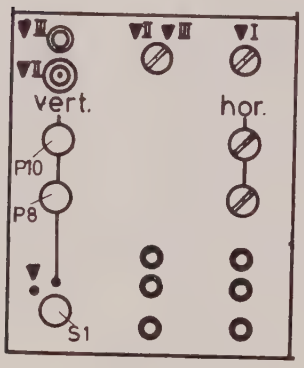


Fig. 10

10. Setting up a Tolerance Scale with vertical level expansion

Connect an attenuator between the specimen and the detector input and set the insertion loss to between 5 and 10 dB. Take care to observe the correct impedance. Then display the measured curve without expansion and adjust the required expansion as

described in the previous paragraph.

Select a point on the curve as a reference point for the tolerance scale and set a frequency marker to coincide with this point (e.g. 1 of the 2 frequency marker lines produced in the frequency marker plug-in unit of the level tracer). At the point where the frequency marker line and the measured curve cross over adjust the first horizontal level line. By adjustment of the attenuator further level lines can be calibrated at the point where the measured and the frequency marker line coincide.

NB It should be remembered that when carrying out selective measurements the switch S7 ("low noise/low distortion") should always be set to 0 dB (low noise).

IV. CALIBRATION

This should be carried out 15 to 30 minutes after having switched on the equipment and rechecked approximately one hour later.

1. ▼I, Calibrating the line p = - ∞

The broadband or the IF amplifier must be plugged into the level tracer. There should be no input signal and the plug should be removed from the input socket during the calibration procedure. The X deflection voltage must be connected.

Switch S1 for vertical expansion should be set to "▼" (figure 11). The level line switch S2 (next to the potentiometers for adjusting the level line underneath the tube) should be in the central position and the brightness control for the level lines (P15) should

be turned up. The line for p = - ∞ should be displayed approximately 1 cemtimetre from the lower edge of the cathode ray tube. Adjust the brightness control for the measured curve (P14) in a clockwise direction and by means of the screwdriver adjustment "▼I" (figure 11) this line should be brought into coincidence with the "p = -∞".

2. ▼II, Calibration for broadband measurements (pE - 40dB)

The broadband amplifier should be plugged into the level tracer and the calibration procedure ▼I (p = - ∞) should be carried out. Set all the switches on the broadband amplifier to "▼" and connect the input socket of the broadband amplifier to " ▼II" in the level tracer main unit. This connects the calibrate voltage to the broadband amplifier. Turn the brightness controls for the calibrate line and the measured curve line in a clockwise direction and bring these two lines into coincidence (approximately in the upper third of the tube) by means of the screwdriver adjustment " ▼II" (figure 11).

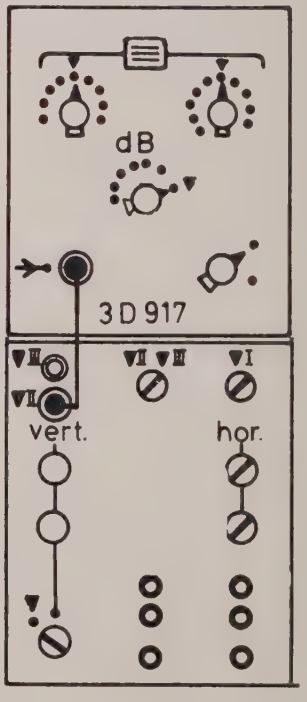


Fig. 11

3. ▼III

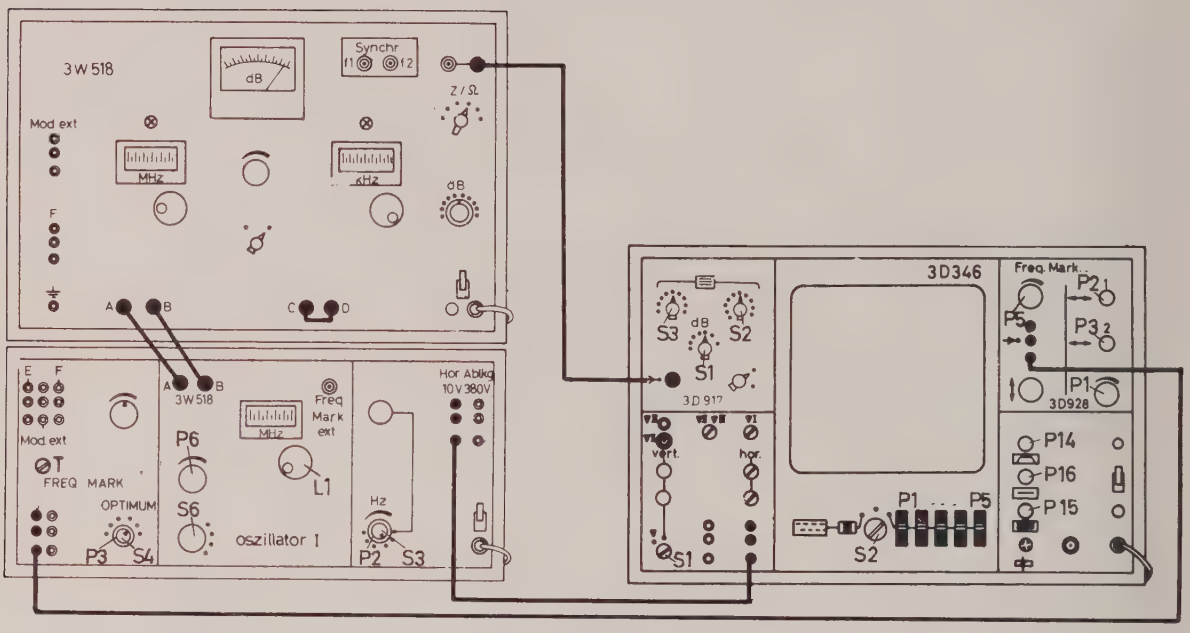
Calibrating voltage of 0 dB is produced at the socket ▼ III. This calibrating voltage is, however, not required for the carrier frequency sweep measuring set 10 Kc/s to 15 Mc/s but will be used for other sweep measuring sets.

4. Calibration for selective measurements

Carry out the calibration procedure "▼I" on the level tracing receiver. Calibrate the frequency and level of the level meter (remove any plug which may be connected in the output socket of the level meter otherwise there will be no indication on the meter). Check the synchronisation of level oscillator and level meter with the level meter set to 200 c/s bandwidth. If necessary adjust the synchronisation f2

Measurements are carried out as described in section VI, page 2.35.

V. FUNCTIONAL CHECK OF THE SWEEP MEASURING SET



1. Plug-in Units required

In the Sweep Attachment	Sweep Oscillator I, W 937
In the Level Tracer	Broadband Amplifier D 917
	Frequency Marker Unit D 928

2. Set up the individual instruments as follows

Level Oscillator W 518

f1 = 1 Mc/s; f2 = 0 Kc/s; level p = 0 dB; Z = 75Ω

Sweep Attachment W 933

a) Sweep Oscillator I, W 937

Centre Frequency (L1) to 1 Mc/s
Sweep Width Coarse (S6) to 80 - 800 Kc/s
P6 fully clockwise

b) Basic Unit W 933
"Sweep Frequency" S3 to 1-5 Kc/s
P2 fully clockwise
Key T "Measuring Frequency" to 100 Kc/s
Switch S4 ("FREQ. MARK. OPTIMUM") to 0.4-4 Mc/s
Fine control P3 should be set to its mid position

Level Tracer D 346

a) Broadband amplifier D 917
Switches S1, S2, S3 should be set to 0 dB

b) Frequency Marker plug-in unit D 928
controls P1 and P5 "brightness" to anti-clockwise stop
controls P2, P3 (↔) to their anti-clockwise stop

c) Basic Unit D 346
Brightness controlsP14, P16 and P15 to their anti-clockwise stops (minimum brightness)
Switch S2 for level lines to the right-hand stop
Controls P1 to P5 should be moved upwards
Switch S1 for expansion and vertical position should be set to "▼".

3. Testing

The brightness control P14 should be turned in a clockwise direction and the measured curve will now be traced. It should be possible by means of S1 in

the broadband amplifier to adjust this curve in 1 dB steps.

Turn the brightness control P16 for the level calibrate line in a clockwise direction. The level calibrate line will then be traced out in the upper third of the tube and by means of switches S2 and S3 in the broadband amplifier it should be possible to adjust this line in 1 dB and 0.1 dB steps respectively.

Turn the brightness control P15 for the level lines clockwise. On the lower edge of the cathode ray tube the line "p = - ∞ " will be traced. The controls P1 to P5 should be turned down one after the other and this will enable five horizontal level lines to be traced. When the level line switch S2 is switched to "off" (mid position) the five level lines should disappear.

Turn the brightness control P5 in the frequency marker unit clockwise until a vertical frequency marker line is displayed in the centre of the tube at a frequency of 1 Mc/s. Adjust the brightness control P1 to its clockwise stop and then turn P2 clockwise and P3 clockwise (↔). Two vertical lines should now be traced which can be moved over the whole width of the screen by means of P2 and P3 (these are auxiliary markers which can be calibrated by means of the main frequency marker).

The width of the frequency markers should be adjustable by means of a control "FREQ. MARK. OPTIMUM" in the sweep attachment, finely by means of P3 and coarsely in steps by means of S4. Set the switch S4 to 0.4-4 Mc/s. The frequency f1 should be changed from 1 Mc/s to 200 Kc/s and then to 1.8 Mc/s. The frequency marker line should hereby move over the whole width of the screen.

If the measuring setup is to be checked for selective reception it should be connected together as shown in attached figure 2b but with a connecting cord (short circuit) replacing the specimen. The impedance switch on the level oscillator and on the level meter should be set to 75Ω and the IF amplifier D 916 should be plugged into the level tracer and the foregoing test carried out.

VI. MEASUREMENT

1. With regulated sending level

Application: For sweep widths greater than 100 Kc/s where a high degree of accuracy is required. First operate the equipment without level regulation and without a specimen and carry out a check to find out whether, with the sweep width required and the accuracy required, level regulation will be necessary. (With no specimen connected the frequency response of the level oscillator will now be traced on the level tracer).

Layout of the measuring setup for broadband measurements is shown in attached figure 1b, and for selective measurements in attached figure 3b.

The required sending level must be adjusted on the level oscillator before connecting the regulating voltage (connection F-F between sweep attachment and level oscillator). For this purpose set the switch S3

on the sweep attachment ("Sweep Frequency") to "0 c/s" and by means of the control "manual" set the centre frequency.

Set the impedance switch on the level oscillator to Z = 0Ω and by means of the fine level control adjust to the desired sending level (reading on the black scale of the meter in the level oscillator). Set the desired impedance value on the measuring probe. The sending level can be set to between + 1 dB and - 10 dB which is the highest regulating factor for a sending level of 0 dB. Join together "F-F" on the sweep attachment and level oscillator. Once the regulating voltage has been connected the sending level from the level oscillator should not be adjusted since the regulating circuit will counteract any variation in the sending level. By means of a double control "sending level automatic" (P4 coarse and P5 fine) adjust the sending level to the value which was set before connecting the level regulating voltage. Small level corrections (less than ± 1 dB) can be adjusted directly by means of the control P5 (figure 12), without the need for previously adjusting the sending voltage.

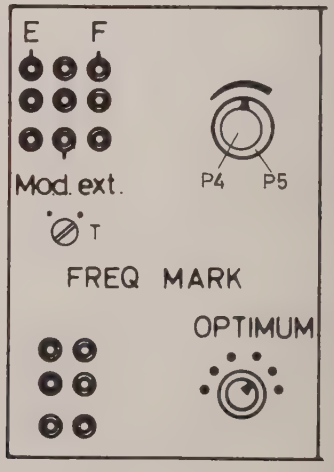


Fig. 12

If lower sending levels are required then it is only necessary to connect an attenuator between the specimen and the probe, adjusting the required level by this means. The key T "lowest measuring frequency" should be set to the lowest swept frequency which will occur.

Example: Centre frequency 200 Kc/s, sweep width ± 50 Kc/s
Lowest swept frequency 200 Kc/s - 50 Kc/s = 150 Kc/s

Set the key T to > 100 Kc/s

Set switch S5 "sending with/without f. markers" to "sending with frequency markers" only when the frequency markers are modulated on the sending level in the form of pips (see 6f, page 24).

2. Measurement of relative level changes

a) Broadband

Carry out calibrate I and calibrate II procedures (see section 4, page 28). By means of the level calibrate line and the level lines set up a tolerance scale.

Starting from a reference point suited to the particular measurement the changes in level can now be easily read on this level scale.

b) Selective

Carry out the calibrate I procedure on the level meter for frequency and level (section 4, page 28).

Check the synchronisation between level oscillator and level meter.

NB Switch S7 "low noise/low distortion" on the level meter should be set to 0 dB ("low noise") (for level meters of the series D 335 d the key "reading - 20 dB" should be in the off position).

Set the level meter to "2 Kc/s bandwidth"

The switch S4 on the IF amplifier input of the level tracer should be set to .0 (pre-amplifier off).

The input divider of the level meter should be adjusted so that the measured curve is displayed in the upper third of the tube. Measurement of level changes can now be carried out on the tolerance scale as with broadband measurements described above.

If very low levels are to be measured the sensitivity of the receiver should be increased by switching S7 "low noise/low distortion" or the key "reading - 20dB", whichever the case may be, to give greater sensitivity and set the bandwidth to 200 c/s (smaller signal to noise ratio).

3. Measurement of absolute level

a) Broadband

Carry out calibrate I and calibrate II procedures (section 4, page 28).

The absolute level of any signal applied can be measured by means of the level calibrate line and its associated attenuator. By means of this level calibrate line and the other level lines it is possible to set up a calibrated tolerance scale and measure absolutely any level lying between these level lines.

b) Selective

If the two instruments have been calibrated together the calibration of the level meter will be maintained when carrying out selective measurements. The following is the procedure to be followed:

1. Calibrate the level meter (see shortform operating instructions for carrier frequency measuring set, page 37).

2. Leave the level meter in its calibrated position.

3. Plug the IF amplifier D 916 into the level tracer D 346.

4. Connect the level tracer to the audio output of the level meter.

5. On the IF amplifier the two switches S2 and S3 and the input switch S1 should be set to 0 dB. In versions of the amplifier with type numbers D 916b the key pre-amplifier (S4) should be set to "on" and for versions Rel 3D 916c the switch S4 should be set to "3D 335".

6. Calibrate the level tracer as described on page 28. Set the controls " II, III" to their mid positions. Turn up the brightness controls for the specimen curve and for the level calibrate line (P16). The level calibrate 0 dB will now be traced in the upper third of the tube.

7. a For versions 3D 916b by means of the control in the adaptor Rel 35D 704 the measured curve should be brought into coincidence with the 0 dB line.

   b For versions 3D 916c by means of the potentiometer "∇" the measured curve should be brought into coincidence with the 0 dB line.

After calibration the measuring setup should be connected for selective measurements.

Note: For IF amplifiers of the series 3D 916b the adaptor Rel 35D 704 should remain plugged in for absolute level measurements.

M A I N T E N A N C E I N S T R U C T I O N S

I. Valves

It is a necessary condition for the correct functioning of the instrument that valves with correct characteristics are used. If, therefore, the equipment does not appear to function correctly it is recommended that the valves should first be checked. Since in some cases the characteristics of the valves affect the calibration of the RF and regulating circuits care should be taken where possible to replace tested valves in the position from which they were removed.

A. Maintenance of the level oscillator Rel 3W 518 and level meter Rel 3D 335

will be as described in the appropriate handbooks for these instruments.

B. Sweep attachment Rel 3W 933

Valves 14 and 15 in the regulating amplifier 35W 548

Connect the pins B and C on the socket of "E" on the front panel with the socket "F" pin C.
Apply a voltage of -1.5 ± 0.1 V from a battery between pin A of the socket "E" and earth.

With a multi-range DC voltmeter having a sensitivity of at least 50,000Ω per volt, e.g. Siemens Microamp Multizet, catalogue No. 231 252, measure the voltage between the anodes of the valve V14 (pins 6 and 1) and by means of P4 and P5 adjust this voltage to 0 V ± 0.5 V. Now measure the voltage between the anodes of the V15 (pins 6 and 1).

This should be $\leq$ 1.6V. If this voltage is $>$ 1.6V then the two triode systems of the valve V15 are unbalanced and this valve should be changed. Finally measure the voltage between the junction of R55 and P4 and earth. Set the Siemens Microamp Multizet to its 10V range. The indicated voltage should be equal to that of the battery voltage which has been connected to the front panel. The maximum variation should be $\leq$ 0.25V. If the variation is $>$0.25V then the two triode systems of V14 are unequal and this valve should also be changed.

C. Level Tracer Rel 3D 346

For the following checks a multi-range DC voltmeter having a sensitivity of = 50,000Ω per V is required, e.g. Siemens Microamp Multizet, catalogue No. 231 252.

1. Valve changes in the high voltage unit 35D 433

Valve V5

measure the anode voltage of valve V21 in the mains unit 35D 437 (solder tags 3 and 8) and by means of R10 in the high voltage unit 35D 433 adjust this voltage to + 250V. Then check the calibrate voltage 0 dB. For this purpose see the section titled "Adjustment of the calibrate voltage 0 dB".

Valves V6 and V7

After changing valves V6 and V7 the calibrate voltage 0 dB should be checked as described in the appropriate section.

Cathode Ray Tube 10 W P 19 A

When changing the cathode ray tube the necessary safety precautions should be taken.

The controls P14 and P16 (brightness of the measured curve and the calibrate line) should be set to their anti-clockwise stops. Connect a DC voltmeter to the

slide of the control P15 and by means of this control adjust the voltage to + 3.0V.
Adjust the controls P1 to P5 so that five spots plus the above spot appear equally spaced over the surface of the tube.
Set P6 so that this row of 6 dots is traced in the centre of the tube. Having done this the adjusted potentiometers should not be moved. These potentiometers can be found by referring to attached figure 1 "front view".

Adjusting the voltages on the cathode ray tube

Control R25 in the high voltage unit 35D 433 should be set so that the six spots referred to above have a diameter of approximately 2 mm.

a) By means of the control R18 and the correcting magnet on the tube, the points should be brought to optimum focus. It should be aimed at obtaining the smallest possible dots.

I N S T R U C T I O N S F O R T E S T I N G A N D F A U L T F I N D I N G

f o r Sweep Measuring Set 32 M 701

I. TESTING INSTRUCTIONS

For a regular check of the complete sweep measuring set consisting of the sweep attachment W 933 with the sweep oscillators I and II the level oscillator W 518, the level tracer D 346 including its plug-in units and the level meter D 335, the functional test as described in the operating instructions should be carried out.

II. FAULT FINDING

Fault finding on the complete equipment consists only of isolating the fault to a particular instrument. Instructions for further fault finding and adjustment can be found in the operating instructions of the instrument in question.

A. Functional Test

For broadband measurements, set up the measuring equipment as shown in attached fig. 1a and for selective measurements as shown in attached fig. 2b of the operating instructions.

First check that all connections and connecting cords have been plugged in correctly (e.g. check the connecting cords for continuity). Then carry out the functional test.

Check whether an error has been made in operating one of the instruments in the measuring setup.

Particular points to be watched

Frequency setting
Level switch setting and impedance switch setting
Synchronising cords when sweeping selectively

a. When sweeping with sweep oscillator I (broad sweep) insert both cords f1 and f2 from level oscillator to level meter.

b. When sweeping with sweep oscillator II (narrow sweep) insert connecting cord f1 from level oscillator to level meter and connecting cord f2 from sweep oscillator to level meter.

For level meters of series D 335 d... the position of the key T, "reading -20 dB" should be checked and for level meters of series D 335 d... onwards, the switch S7, "low noise/low distortion", should be set to 0 dB. (When either the key is switched in or the switch S7 is in a position other than 0 dB the noise level will be greater and this will cause the measured curve to be affected by this noise). Check that all connecting cords are plugged in correctly and that all cords

have continuity.

Hint

If the measured curve is modulated by an interfering voltage check the mains unit of the sweep attachment W 933 for hum voltage as described in "Testing Instructions W 933", and note the hint on page 11 in the "Testing Instructions for Sweep Oscillator I, W 937".

All voltages given in these Instructions are nominal values and unless other tolerances are stated are permitted a variation of ± 10%.

2

B. Isolating the fault to a particular instrument

1. Level Oscillator W 518 and level meter D 335

a) Calibrate the frequency and level on both instruments

b) Check the synchronisation

c) Carry out a check measurement using synchronisation and adjusting the frequency by hand over the whole band without connecting the sweep attachment and level tracer.

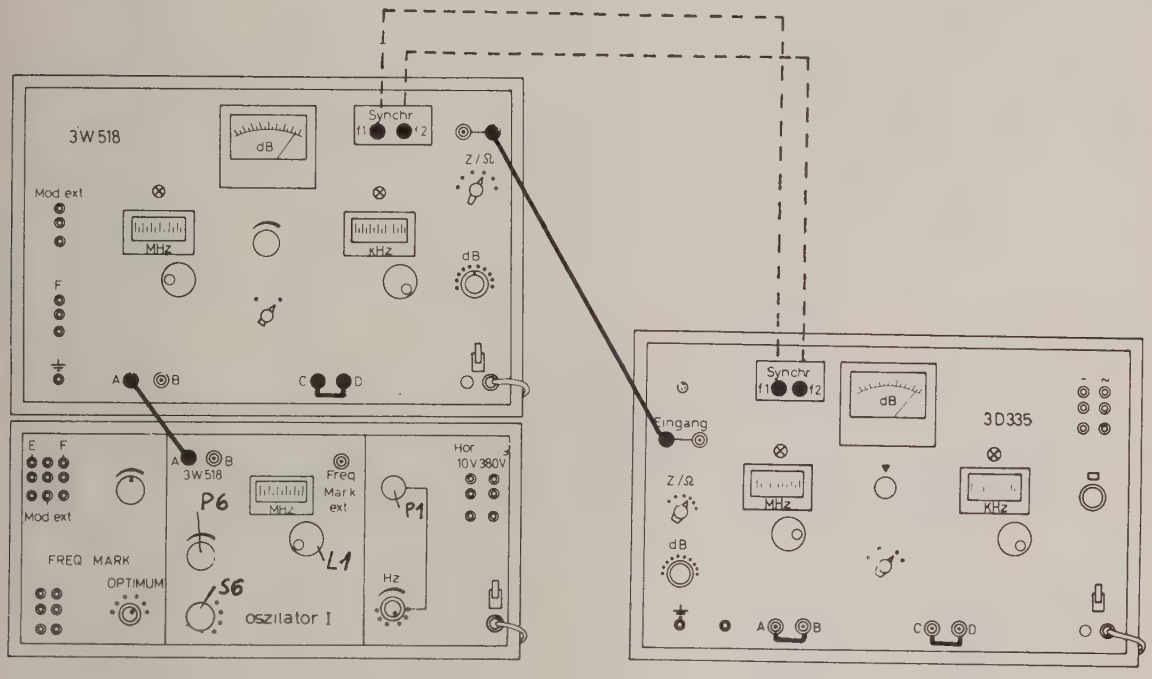
d) Measure the a.c. (3 Kc/s) signal at the output "∿" of the level meter when the meter is showing 0 dB. The nominal voltage should be approximately 8.0 V.
(See the shortform operating instructions CF Level Measuring Set, section VII of the operating instructions of the CF Level Measuring Set 17 Mc/s).

2. Sweep Attachment W 937

The sweep oscillator I should be inserted in the sweep attachment.

a) Checking the deflection voltage on the sweep attachment. Connect a d.c. voltmeter to socket "Hor. deflection 10 V" between conductors c and d (⊥/~). Set switch S3 "sweep frequency" to 0 c/s and adjust control "Manual" from beginning to the end of its track. The indicated voltage should vary from approximately -5 V through 0 V to +5 V. Set switch "sweep frequency" to a low frequency, e.g. 0.01 - 0.05 or 0.05 - 0.25. The voltage at the socket "Hor. deflection" should now vary automatically from approximately -5 V to +5 V and back. If this voltage is not present refer to the testing instructions for the sweep attachment "Testing the Control Oscillator". If the voltages are present as described above but the trace on the level tracer is not deflected horizontally, then refer to the testing instructions for the level tracer "Testing of the Horizontal Amplifier".

b) Testing the Sweep Attachment with sweep oscillator I, W 937



Layout of the Measuring Setup

Set the level to 0 dB and the impedance switch to 75 Ω on both the level oscillator and level meter.

Set the switch S3 "sweep frequency" to 0 c/s

On sweep oscillator I set switch S6 to 800 - 7,500 Kc/s, the fine control P6 to its right-hand stop and the control L1 "centre frequency" to 8 Mc/s.

Slowly tune the control P1 "manual" through its range. The output frequency should then change over the frequency range of the level oscillator from 10 Kc/s to 15 Mc/s. The indication on the level meter must be approximately 0 dB ± 1 dB within the frequency range 30 Kc/s to 15 Mc/s. At 17 Mc/s the indication will probably fall by approximately 4 dB.

4

Measuring the Frequency Limits

All the above settings should remain but the synchronising cords between level oscillator and level meter should be removed.

Lower Frequency Limit:
Set the level meter to f = 30 Kc/s and pass-band 2 Kc/s. Adjust P1 "manual" on the sweep attachment slowly in an anti-clockwise direction until the level meter shows approximately 0 dB in the vicinity of the left-hand stop of P1 = 30 Kc/s.

Upper Frequency Limit:
Set the level meter to 15 Mc/s and turn the control P1 clockwise until the level meter reads 0 dB in the vicinity of the right-hand stop of P1 (approximately 15 Mc/s). If the frequency is not produced then refer to the testing instructions for the sweep attachment "Testing the Sweep Oscillator I, W 937". If the above values are obtained then refer to the testing instructions for the level tracer "Testing the Horizontal Amplifier".

c) Testing the sweep attachment with sweep oscillator II, W 938

The layout of the measuring set is as described under b), but instead of having the connecting cords "a - b" sweep oscillator I - level oscillator these should now be plugged into the sockets "c - d". Only connect the synchronising cord f1 between level oscillator and level meter.

On the level oscillator and level meter set the level to 0 dB and Z = 75 Ω, frequency f1 to 1 Mc/s with lock-in

On the sweep attachment set the switch S3 "sweep frequency" to 0 c/s and set the control P1 "manual" to its left-hand stop.

On the sweep oscillator II set the control "sweep width" to its right-hand stop and the control "centre frequency" to 0 Kc/s.

On the level oscillator the green lamp "f2 - indicator" should light. If not refer to testing instructions for "Sweep Oscillator II, W 938"

Tune the level meter by means of the f2 control to the frequency of the sweep oscillator. This should be 0 Kc/s ± 5 Kc/s. The meter on the level meter must show approximately 0 dB. Turn the knob "centre frequency" on the sweep attachment from 0 Kc/s to 100 Kc/s. The green lamp "f2 indicator" on the level oscillator should not be extinguished during this operation. The frequency at the output of the level oscillator (measure by means of level meter using frequency scale f2) should change by 100 Kc/s. If this is not the case refer to testing instructions for "Sweep Oscillator II".

Set the switch "sweep frequency" on the sweep attachment from 0 c/s to 0.01 .... 0.05 c/s or a higher sweep frequency. The frequency will now be automatically swept approximately ± 10 Kc/s. During this operation the green lamp "f2 indicator" should not extinguish. If this does happen then refer to the testing instructions for "Sweep Oscillator II."

Connect the synchronising cord from the sweep oscillator (SYNC. f2) to the level meter. The frequency f2 of the level meter will now be automatically controlled from the sweep oscillator. During the sweep the indication on the meter of the level meter should remain constant at approximately 0 dB. The green lamp "f2 indicator" of the level meter should not be extinguished.

Fault finding: see testing instructions for "Sweep Oscillator II".

d) Setting up the frequency markers

First check to see whether the instrument is being correctly operated and in particular check the setting of the switch S4 "FREQ. MARK OPTIMUM" on the sweep attachment. If the frequency markers are still not correctly displayed then refer to the testing instructions for the sweep attachment "Frequency Marker Amplifier and High-pass/Low-pass Filter".

e) Automatic level regulation (with sweep oscillator I)

Check to see whether the instrument is being correctly operated. Refer to the operating instructions, section VI, paragraph I, "Measurements with Regulated Sending Level".

Fault finding is described in the section sweep attachment "Regulating Amplifier".

connecting cords

1 Rel ltg 592b
2 Rel ltg 664 i
3 Rel ltg 546d
4 Rel ltg 533d
5 Rel ltg 546a
6 Rel Bv 657 A 119 c 4
7 Rel ltg 598d
8 Rel ltg 598b
9 Rel ltg 592d
10 Rel ltg 538d

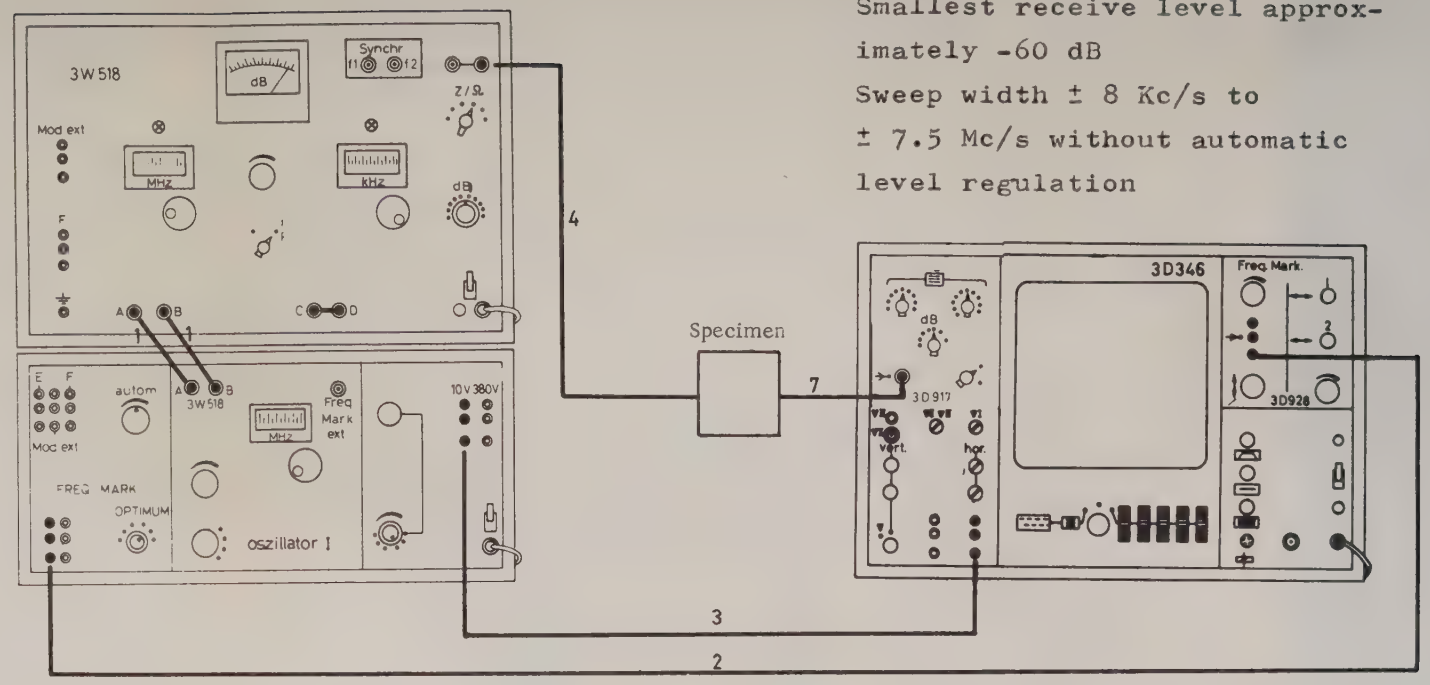


Diagram 1a

Broadband measurement with 3 frequency markers
Smallest receive level approximately -60 dB
Sweep width ± 8 Kc/s to ± 7.5 Mc/s without automatic level regulation

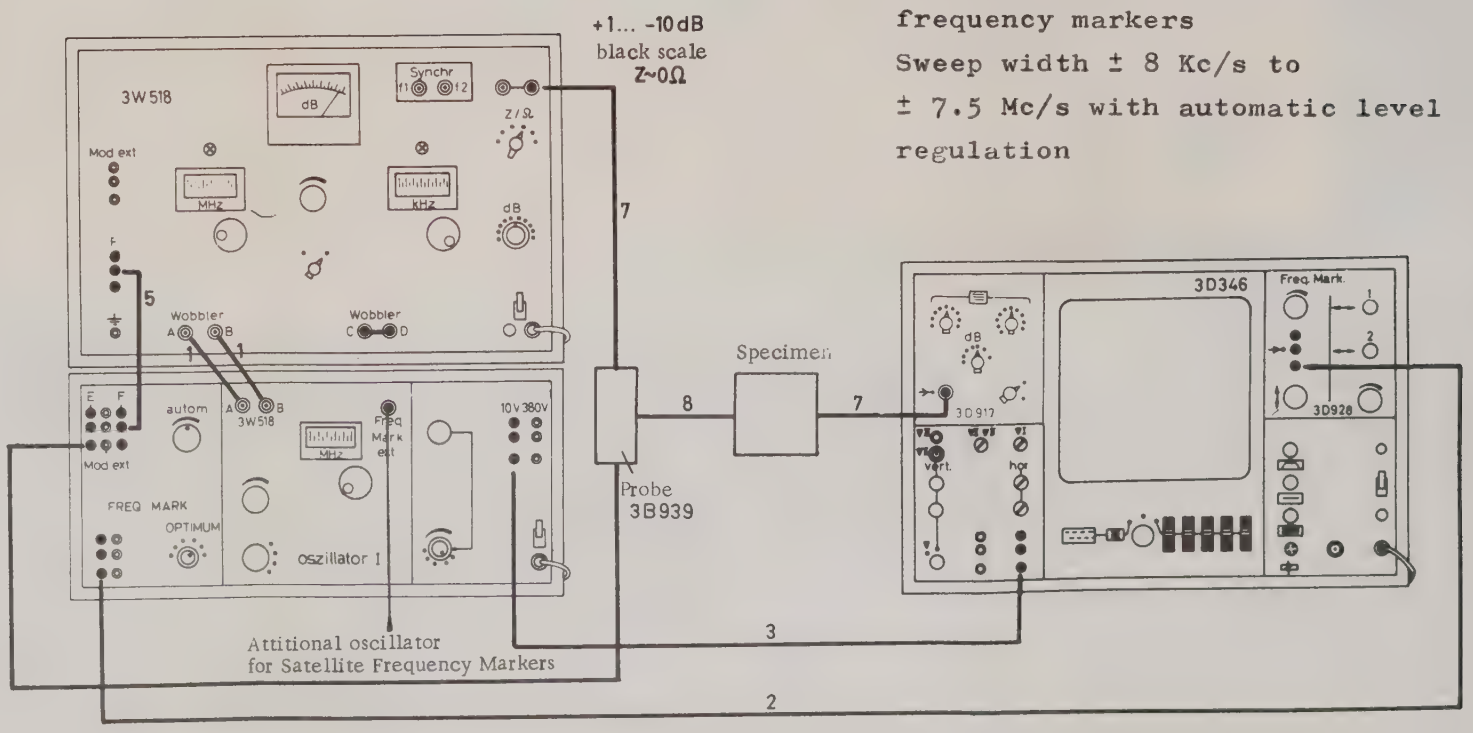


Diagram 1b

Broadband measurement with 5 frequency markers
Sweep width ± 8 Kc/s to ± 7.5 Mc/s with automatic level regulation

Diagr. 1a
Diagr. 1b

connecting cords

1 Rel ltg 592b
2 Rel ltg 664 i
3 Rel ltg 546d
4 Rel ltg 533d
5 Rel ltg 546a
6 Rel Bv 657 A 119 c 4
7 Rel ltg 598d
8 Rel ltg 598b
9 Rel ltg 592d
10 Rel ltg 538d

Diagram 2a

Broadband measurements
Smallest receive level approx-
imately -60 dB
Sweep width ± 500 c/s to
± 10 Kc/s
Level regulation is not required

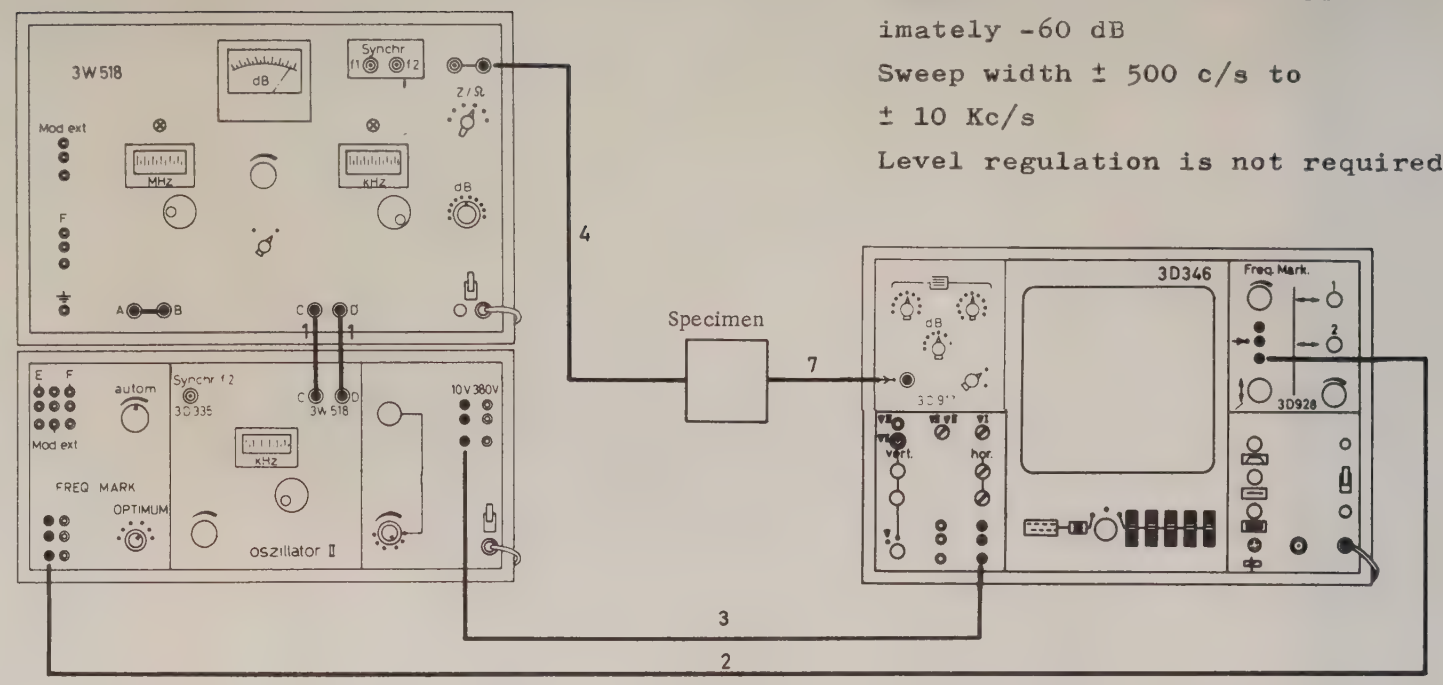
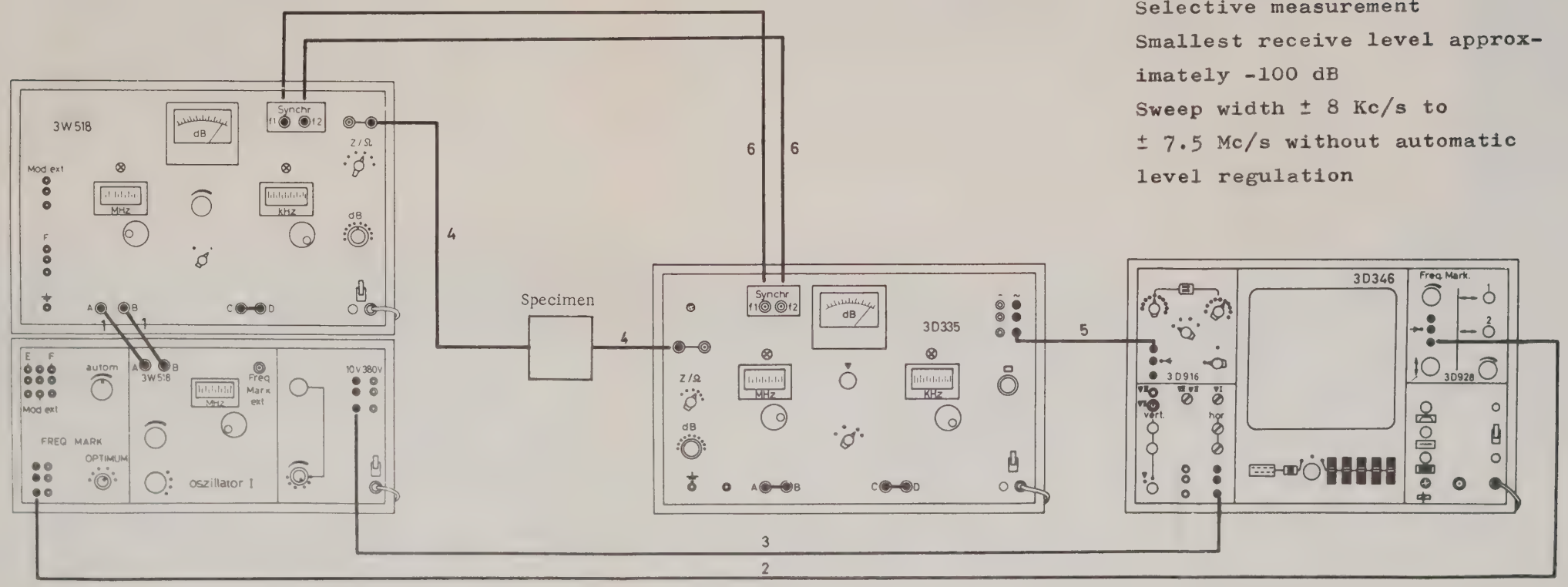


Diagram 2b

Selective measurement
Smallest receive level approx-
imately -100 dB
Sweep width ± 8 Kc/s to
± 7.5 Mc/s without automatic
level regulation



Diagr. 2a
Diagr. 2b

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Diagram 3a

Selective measurement

Smallest receive level approximately -100 dB

Sweep width ± 8 Kc/s to ± 7.5 Mc/s with automatic level regulation

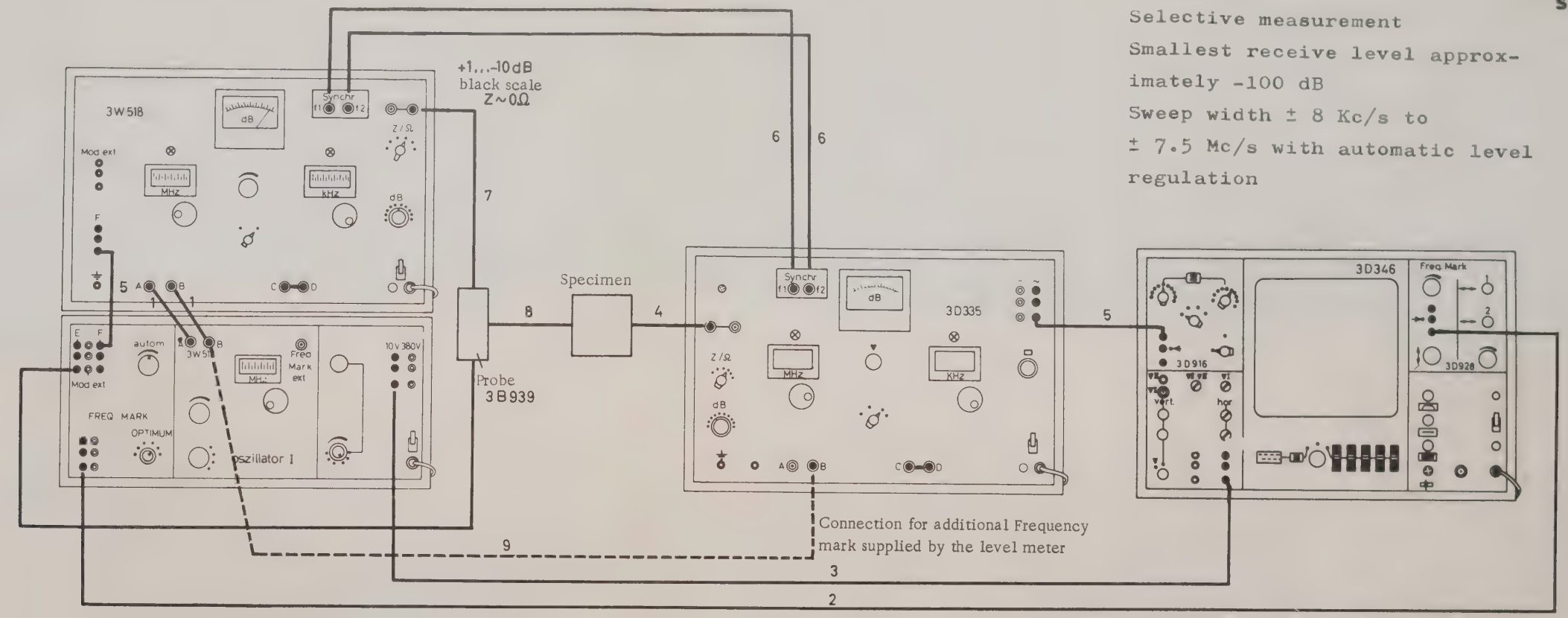
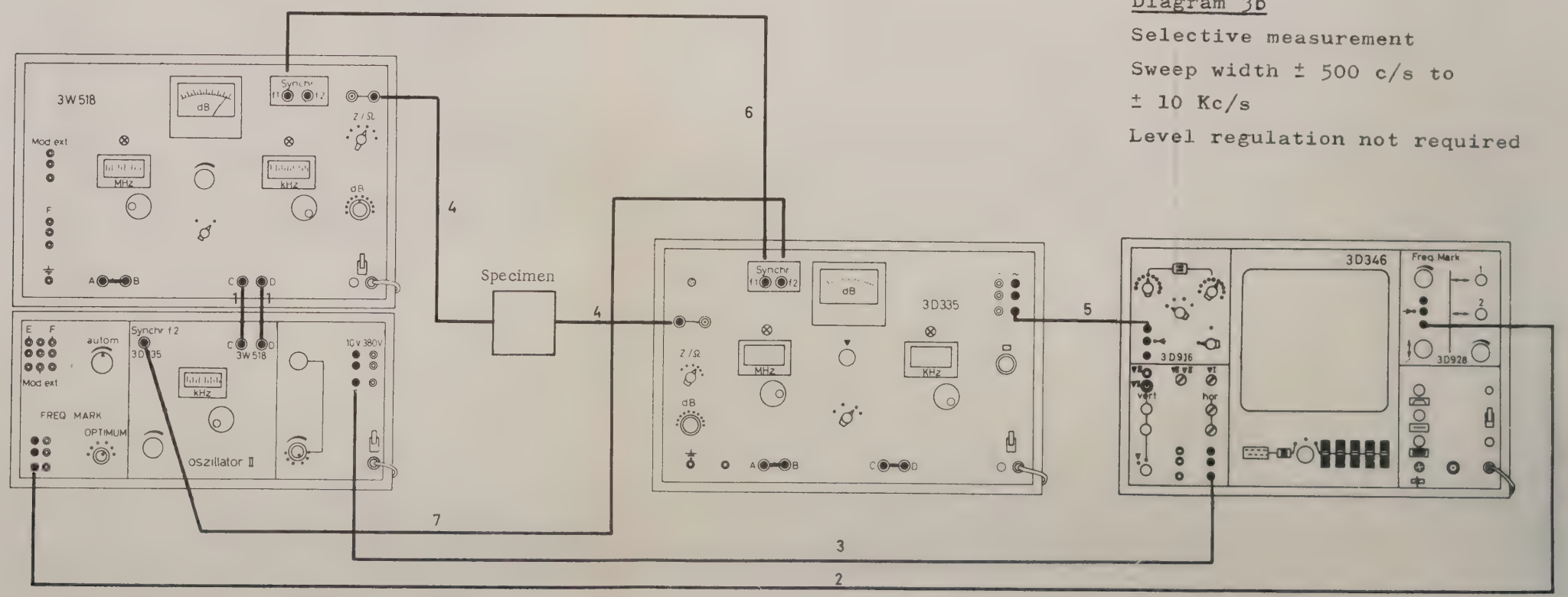


Diagram 3b

Selective measurement

Sweep width ± 500 c/s to ± 10 Kc/s

Level regulation not required



connecting cords

1 Rel ltg 592b
2 Rel ltg 664 i
3 Rel ltg 546d
4 Rel ltg 533d
5 Rel ltg 546a
6 Rel Bv 657 A 119 c 4
7 Rel ltg 598d
8 Rel ltg 598b
9 Rel ltg 592d
10 Rel ltg 538d

Diagr. 3a
Diagr. 3b

SIEMENS

Diagram 4a

Spectrum Analysis (Panoramic Reception) with level meters of series D 335 d... and e...

Smallest receive level approximately-100 dB

Sweep width ± 8 Kc/s to ± 7.5 Mc/s

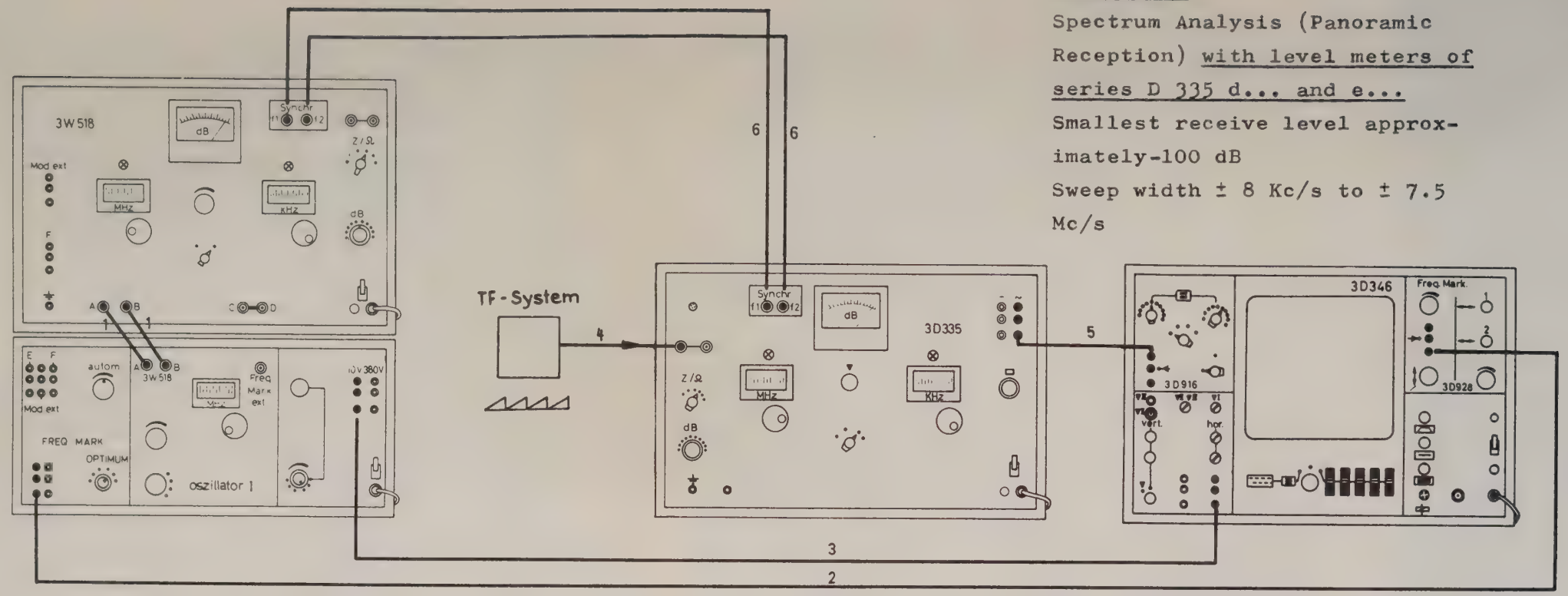


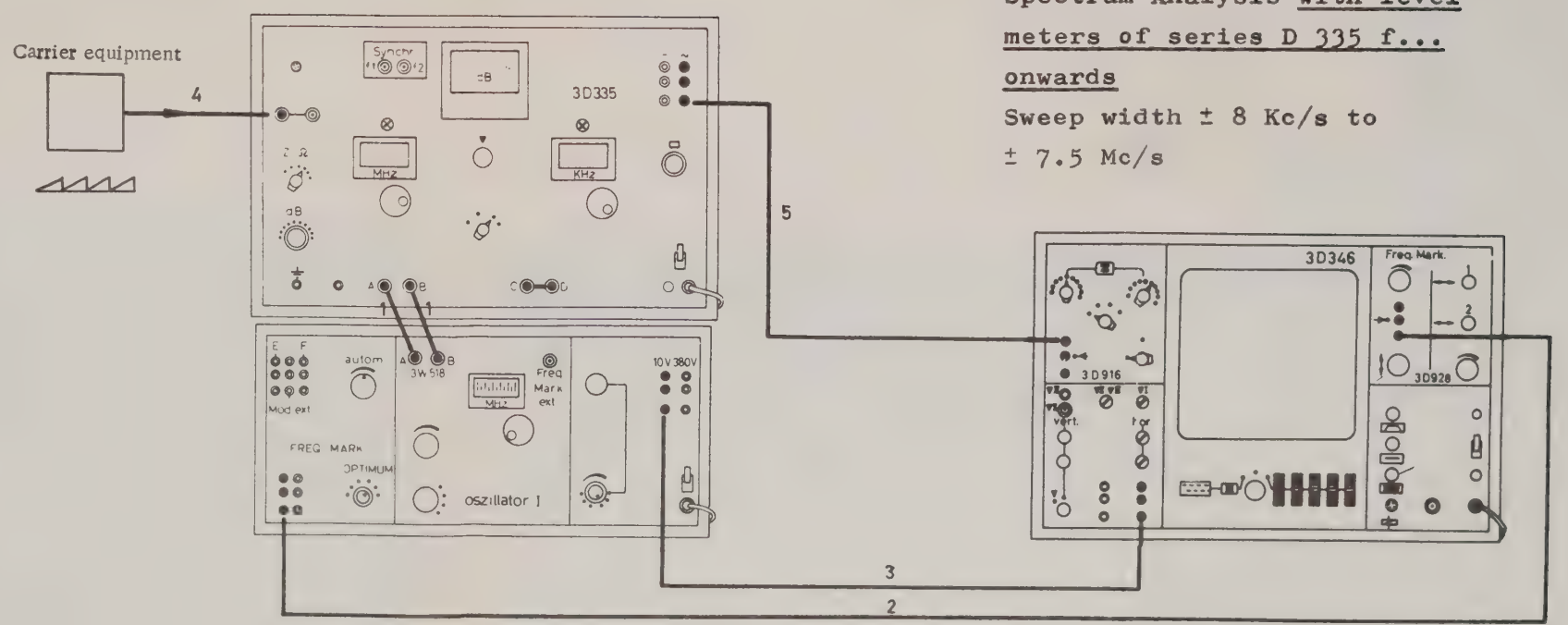
Diagram 4b

Spectrum Analysis with level meters of series D 335 f... onwards

Sweep width ± 8 Kc/s to ± 7.5 Mc/s

Connecting cords

1 Rel ltg 592b
2 Rel ltg 664 i
3 Rel ltg 546d
4 Rel ltg 533d
5 Rel ltg 546a
6 Rel Bv 657 A 119 c 4
7 Rel ltg 598d
8 Rel ltg 598b
9 Rel ltg 592d
10 Rel ltg 538d



Diagr. 4a
Diagr. 4b

SIEMENS

Diagram 5

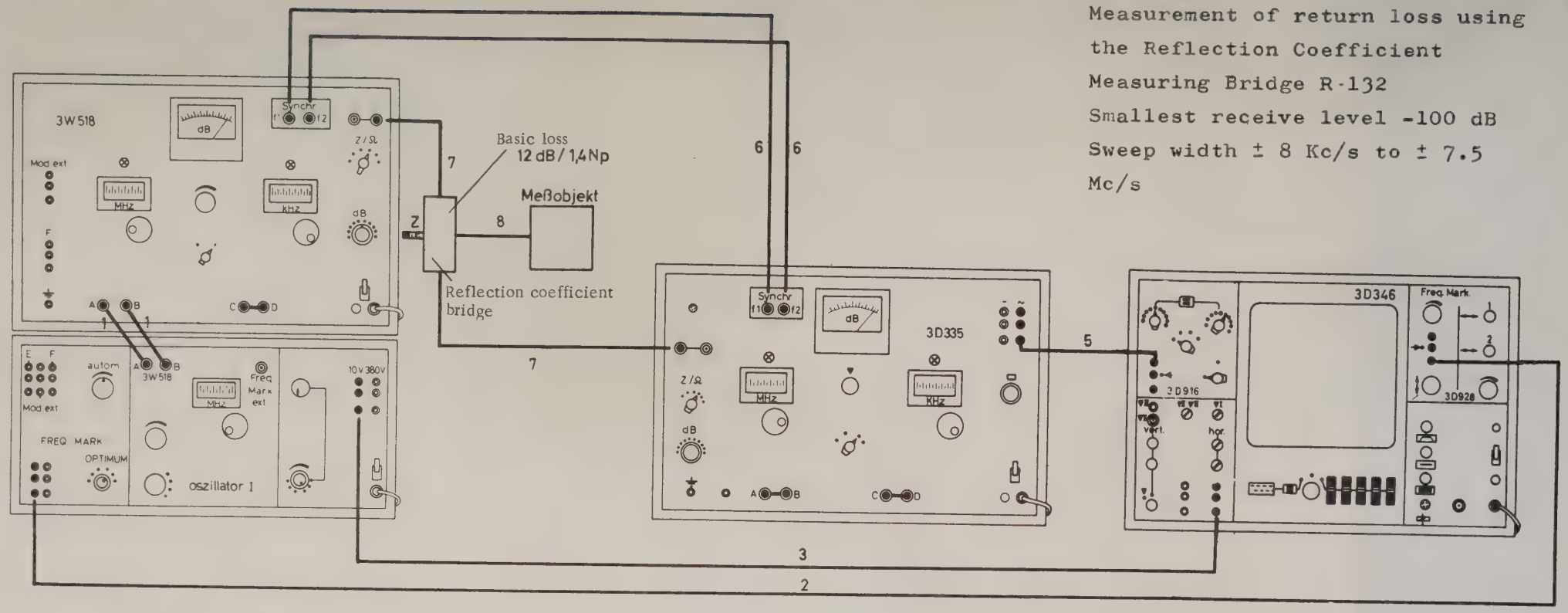
Measurement of return loss using the Reflection Coefficient Measuring Bridge R-132

Smallest receive level -100 dB

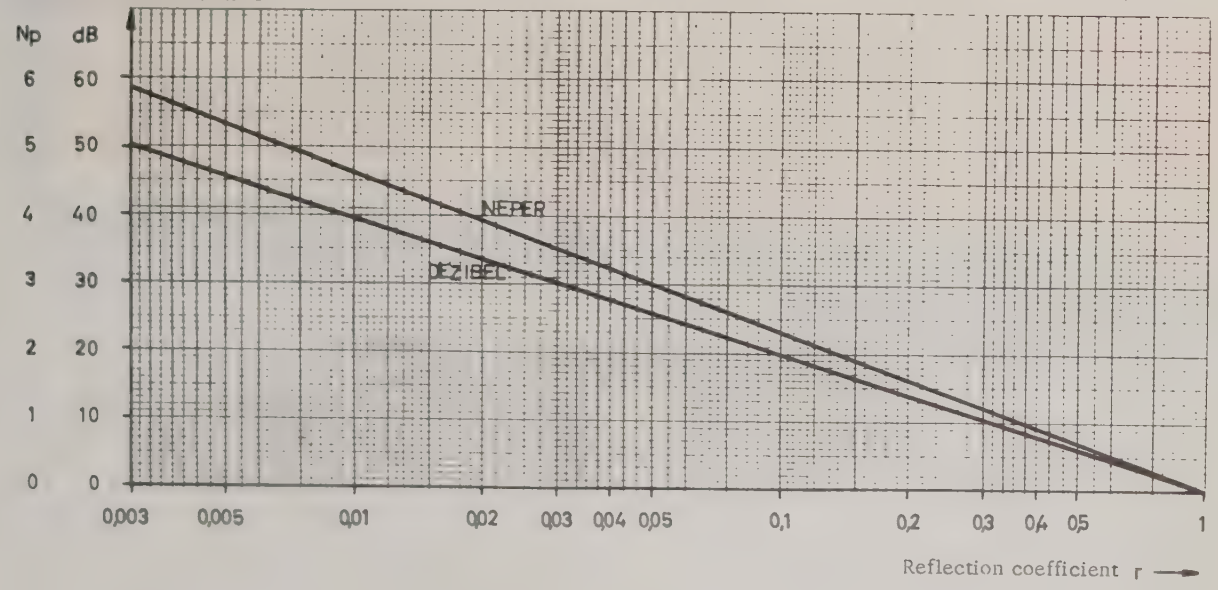
Sweep width ± 8 Kc/s to ± 7.5 Mc/s

connecting cords

1	Rel ltg	592b
2	Rel ltg	664 i
3	Rel ltg	546d
4	Rel ltg	533d
5	Rel ltg	546a
6	Rel Bv	657 A 119c4
7	Rel ltg	598d
8	Rel ltg	598b
9	Rel ltg	592d
10	Rel ltg	538d



Determining the reflection coefficient from the return loss.



Measuring Procedure

First of all insert the reflection coefficient standard B 3122 in the reflection coefficient bridge. Set the centre frequency and sweep width according to the range of measurement required and set up the desired tolerance scale.

Example 1:

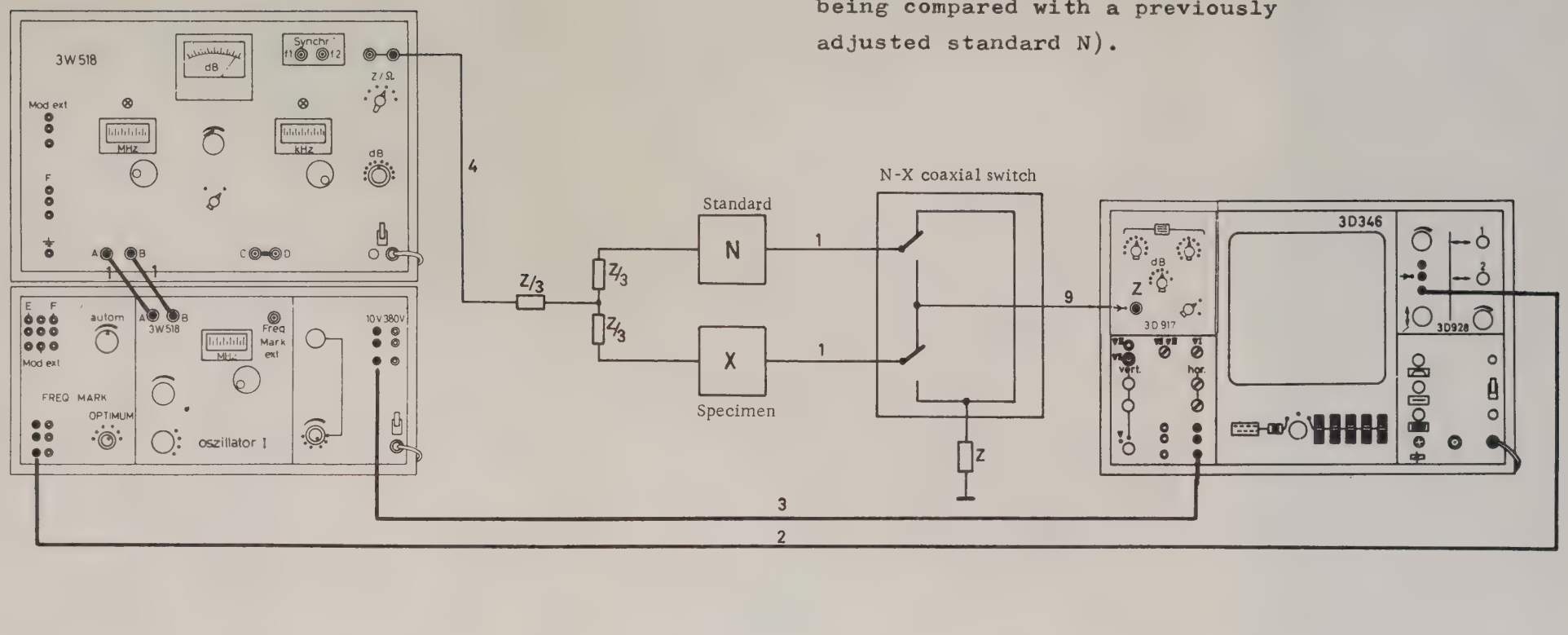
Anticipated return loss > 20 dB, the desired tolerance scale being 18, 20, 22, 24 and 26 dB. Set the calibrating line of the 10 dB steps to -10 dB. Adjust the sensitivity of the receive section and the send level so that the calibrate line for R = 0.05 = return loss 26 dB is in exact coincidence with the calibrate line -10 dB, i.e. the -10 dB line corresponds to a return loss of 26 dB. By means of the calibrate line set up the desired tolerance scale starting from this first line by means of the level line controls at the base of the level tracer (return loss 26 dB = calibrate line -10 dB; return loss 24 dB = calibrate line -8 dB; return loss 22 dB = calibrate line -6 dB etc, etc.). Now remove the reflection coefficient standard and connect up to the specimen, measuring the return loss of the specimen within the tolerance scale.

Example 2:

Expected return loss > 35 dB; the tolerance scale of 35, 40, 41, 42, 45 dB will be required. Set the calibrate line to -10 dB starting at the lowest tolerance line (45 dB). Set up a tolerance scale (45 dB = calibrate line -10 dB; 42 dB = calibrate line -7 dB; 41 dB = calibrate line -6dB etc. etc.). The attenuation of the reflection standard (20 dB) dose not lie within the measuring range required (35.....45 dB). Therefore, reduce sending level by 10 dB. The calibrate line, therefore, for a return loss of 26 dB will now be transferred to 36 dB. This value lies within the measuring range. Now set the calibrate line to 36 dB. Since the calibrate line in the position -10 dB corresponds to a return loss of 45 dB the calibrate line for 36 dB should be set to 0 dB. Now adjust the sending level so that the calibrate line for return loss coincides with the calibrate line -10 dB. Now adjust the sending level 10 dB higher and instead of the return loss standard, insert the specimen and measure the return loss of the specimen within this calibrated scale.

Diagram 6

Broadband measurements using the comparison method (specimen X being compared with a previously adjusted standard N).



connecting cords

1 Rel ltg 592b
2 Rel ltg 664i
3 Rel ltg 546d
4 Rel ltg 533d
5 Rel ltg 546a
6 Rel Bv 657 A 119 c 4
7 Rel ltg 598d
8 Rel ltg 598b
9 Rel ltg 592d
10 Rel ltg 538d

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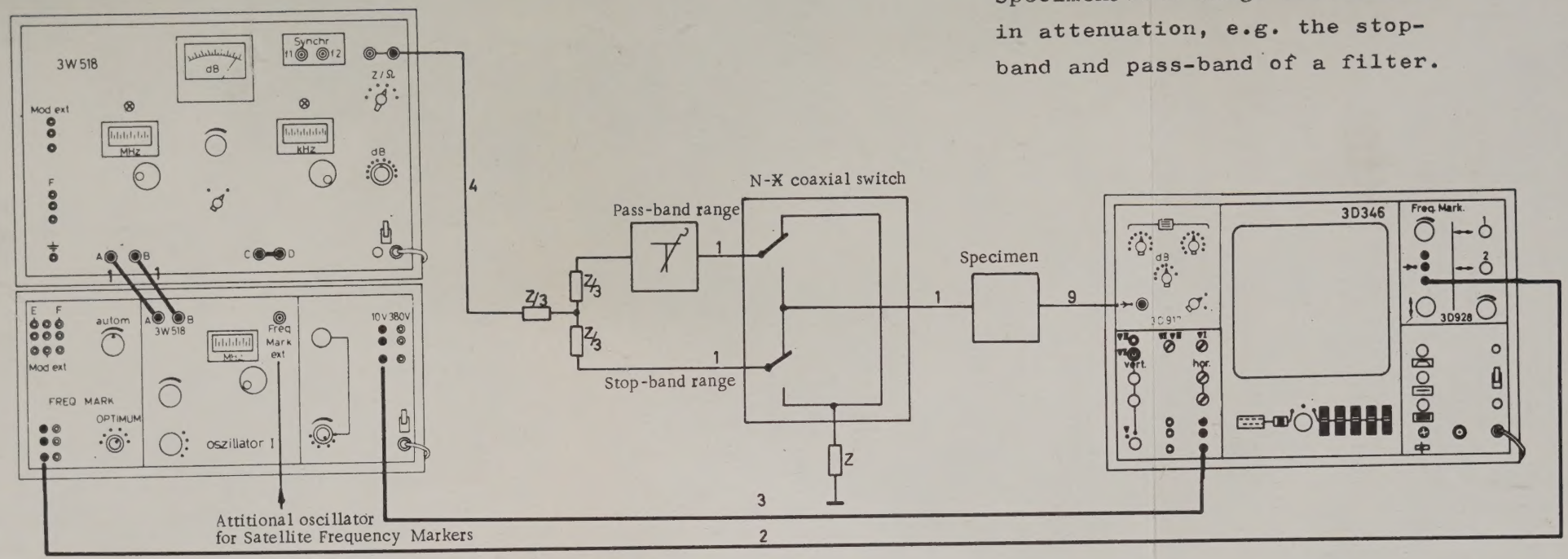
Diagram 7

Measurement and adjustment of specimens with large differences in attenuation, e.g. the stop-band and pass-band of a filter.



connecting cords

1 Rel ltg 592b
2 Rel ltg 664i
3 Rel ltg 546d
4 Rel ltg 533d
5 Rel ltg 546a
6 Rel Bv 657 A 119 c 4
7 Rel ltg 598d
8 Rel ltg 598b
9 Rel ltg 592d
10 Rel ltg 538d

Measurement Procedure

The centre frequency and sweep width should be set up according to the pass-band and stop-band being investigated. Set the N-X switch to "stop-band range" and adjust the sensitivity of the receiver or the level from the level oscillitor so that the measured curve of the stop-band is traced in the lower half of the screen and is centrally positioned. The required tolerance scale and frequency markers should now be set up.

Now switch the N-X switch to "pass-band range". Adjust the attenuation of the attenuator so that the pass-band curve is traced in the upper third of the screen, (under no circumstances should the sending level or the sensitivity of the receiver be changed).

Now set up the required tolerance scale and frequency markers for this curve. If the five tolerance lines of the level tracer are not sufficient, the level line setter B 945 should be used (8 lines). If an N-X switch is not available then switching can be carried out manually but the sweep speed should be set correspon dingly slower. Refer to the section "Application", page 11. If the sensitivity of the above setup is insuffi-cient for the stop-band, the level meter D 335 should be connected in front of the level tracer as shown in attached fig. 2b.

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